HOW TO FEED THE DAIRY COW

HUGH G. VAN PELT

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By Hugh G. Van Pelt

BREEDING AND FEEDING
DAIRY CATTLE

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Editor
KIMBALL'S DAIRY FARMER

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How to Feed the Dairy Cow

BREEDING AND FEEDING DAIRY CATTLE

[An Introduction to the book on "Feeding the Dairy Cow."]

The value of a herd of dairy cattle depends upon the methods employed in the breeding and feeding. Other factors enter in to assist or retard the efforts of the breeder, but, regardless of all skill employed in otherwise managing the herd, to ignore the laws of breeding and the principles of feeding is to invite failure.

Breeding and feeding go hand in hand. He who applies the principles of feeding and disregards the laws of breeding, or vice versa, cannot realize the greatest success.

It matters little how well bred the sire and dam may be, improper feeding will dwarf the traits of excellence that should be transmitted to the offspring.

Again, it matters little how expert the feeder, little will be accomplished if the animals are poorly bred, and he who would succeed in attaining either wealth or fame by improperly feeding cattle descended from mediocre breeding has but one chance in a thousand of realizing his aim.

I am at present, however, a breeder and feeder of dairy cattle, and I believe those phases of the subject which may be put to practical use for increasing production and insuring improvement of future herds will be more welcome to my readers than a discussion of the scientific laws that underlie breeding and feeding.

To attain success in any business it is necessary to have a proper starting point and then to proceed in the right direction. Failure is often the result of starting wrong and proceeding in the wrong direction or traveling in circles. This is more true of the breeding of livestock than of nearly any other business, for the one who starts with the wrong sire and continues to use sires of this kind forever travels in the wrong direction. He walks on a tread power, and, though he keeps everlastingly at it, never arrives. He who alternates good sires with poor sires travels in circles. He progresses at times, but usually finishes up at about the same point from which he started.

The breeder who is walking in the tread power or traveling in circles—and many of us are guilty—must start over before he can

expect to succeed. If he would attain his purpose he must first have clearly in mind what his purpose is. If he would breed cows of great producing capacity he must mate his animals with that end in view. If he would breed cows with show-yard characteristics he must follow systematically the path which leads to purple ribbons.

Comparatively speaking, these roads are smooth and well trodden, but if he could breed cattle possessed at once of great and economical milk and butter-producing qualities together with show-yard characteristics—beauty, type and conformation—he will find a rougher road, for it is traveled less than the tread powers and circles for either of the pathways leading to the productive cow or the beautiful show-ring champion.

It is for the breeder himself to decide definitely just what kind of an animal he will breed. He must have a clearly defined mind's-eye picture of the image he would mold by the persistent and intelligent mingling of blood lines through a lifetime of effort. If production is his desire, bulls from long lines of producing ancestry must be used. The greatest of all laws of breeding—like begets like—is as true today as in the days of Cruickshank, Booth, Bates, Hugh Watson and many others whose names will live in history as long as the cattle breeding industry survives. If he desires to breed excellence of type, form and conformation, the slogan now threadbare with age is true: "Breed from the winners."

Truly believing it possible, yet realizing that the process is more difficult to breed great producers possessing acceptable type, conformation and beauty than to secure either feature without the other, my suggestions will be along that line.

The starting point is in the bull pen. Analyze your bull. Demand that he shall come up to a rigid standard of excellence, and follow up that demand by replacing him with another bull if he does not.

If your mind's-eye picture calls for a cow that yields annually 500 pounds of butterfat, make sure your bull's feminine ancestors for six generations were cows that could perform at that rate; also that the paternal ancestors were progenitors of such cows. Perhaps the pedigree does not show them with such records, but it should indicate that the ability to make those records was present. I say all ancestors, and I specify six generations of ancestors, for a bull, although more likely to transmit the characteristics of his dam, will also transmit characteristics of his more remote ancestors. That is why Holstein calves sometimes come red and white and Aberdeen Angus calves come all red, though not for

scores of years have these foreign colors been accepted to registration. This reversion to species is common to all kinds of livestock.

You can journey but once from the cradle to the grave. Do not let your epitaph read that you made the journey with a dairy bull that did not possess the first fundamental qualities of dairy breeding

If the bull's pedigree is acceptable in the important respects mentioned, you are ready to proceed. If your ambitions call for more than production alone, secure description of the conformation of the same ancestry. Look for show-yard records. Remember that the present-day greatness of all breeds of beef cattle, draft horses and other domestic animals is largely the result of the mating of prize winners and thus preserving their blood.

If no prize winnings are to be found in his pedigree, bear in mind that he who attends great shows without his cattle and claims he has better individuals at home is probably less than 90 per cent right, and that your herd bull, even though a good individual himself, may not transmit with certainty his own conformation, for like either begets like or the likeness of an ancestor.

If your bull fails here, dispose of him, but if in each respect the pedigree is acceptable, study the bull himself, remembering that "like begets like as well as the likeness of an ancestor."

Your mind's-eye picture of the cow you would breed is clearly defined. She must be good all over.

Starting at the head to insure systematic procedure, it is a recognized fact that a large mouth indicates a good feeder; a large nostril, constitution; a face clean cut and of good length, well dished between large, prominent, bright eyes points to excellence of dairy temperament.

These, being desirable in the cow, are also necessary in the sire that he may transmit them, thus insuring their prominence in the next generation. Furthermore, the head of the bull must, through its appearance of masculinity, indicate strength of character and prepotency. It matters not how excellent in breeding and individuality a bull may be; if he does not have the prepotent power necessary to stamp on his get his characteristics and those of his ancestors, he is of little value. The effeminate sire permits the cows of the herd to stamp the various points peculiar to themselves and their progenitors, thus eliminating the uniformity of type, conformation and productiveness.

The neck of the cow should be of good length, blending neatly into shoulders free from beefiness and with the backbone slightly protruding above, insuring a wedge-shaped conformation. The sire—though because of masculinity bearing a heavier-crested neck—should

also possess length in this part and shoulders bearing close resemblance to those of the desired cow, that his offspring may conform to the requirement.

As surely as it is desirable to have cows long from the shoulders to the hip bones, well sprung in the ribs, open-jointed and free from beefiness along the backbone, deep in the body, with a covering of soft, pliable and elastic hide, which in turn is covered with soft and silky hair, these qualifications must also be presented by the sire if they are to be expected in his offspring.

Prominent hip bones are desirable in the dairy cow, and great length and straightness from these points to the pin bones insure length of udder and one that carries well forward with front quarters well rounded out. Therefore, it is very essential that the sire that is expected to impress these characteristics on the next generation should comply with this conformation.

The cow of your dream must have a broad udder attached high behind. To be thus possessed she must be well arched between thin, incurving thighs. Cows that are beefy in the hind quarters lack place of attachment for long, broad udders.

To insure this essential it is necessary that sires used in the attempt to secure the ideal cow must be thin of thigh, cut high up and well arched out in the hind quarters.

That cows of great capacity and ability may utilize the milk-making nutrients digested from foods consumed, there must be an abundance of blood circulating from the digestive organs carrying these nutrients to the udder. The volume of this circulation is indicated by large, long and tortuous milk veins and by large and numerous milk wells. Cows with short, straight, small veins and only two small milk wells will seldom be found to be 500-pound cows. Bulls vary almost as greatly as cows in these respects. Therefore, the sire should be well veined.

Rudimentaries, if small and placed close together on the sire, indicate that his daughters will have small teats placed close together.

With all details of form and conformation approaching perfection the sire must possess size, color markings, style and general appearance in keeping with the breed he represents. If your bull is extremely faulty in any of these requirements when in proper condition, life is too short and good bulls are too plentiful for you to use him unless he is especially valuable in correcting certain defects in your herd without incurring worse ones.

By the use of even the very best sires disappointments occur. Progress is slow. Breeders do not accomplish great success in one

generation of breeding. Even a lifetime honestly and intelligently employed is too short a period for most breeders to realize their ambitions where lack of experience or financial restrictions compel them to start with a heterogeneous collection of females.

More often advancement is retarded by improper selection of a good herd bull's successor than by the use of the wrong bull in the beginning. When a bull is placed in service, your efforts to secure his successor should immediately begin. The time between the use of the first bull and the breeding age of his daughters is almost too short for locating just the right bull. Fortunate is the breeder who, in a lifetime, is successful enough to control the services of one outstanding sire; and doubly fortunate is he who makes no mistake in selecting sires that will improve upon or even perpetuate the good qualities transmitted by one renowned sire.

Outcrossing and inbreeding are uncertain tools in the hands of the breeder who strives for certain and uniform results. Either method properly employed will insure some excellent animals, but, because they are radical procedures, they are liable to interfere with uniform results, which means that a great many inferior offspring are liable to come along with a few excellent ones by following promiscuously either inbreeding or outcrossing.

A more certain method is line breeding, which differs from inbreeding in that it consists of mating animals remotely related rather than those closely related. Owing to the fact that the greatness of the progeny of a sire comes largely through his dam, one excellent plan of line breeding is that of using a second bull whose dam is the best sister of the first bull's dam and whose sire—furnishing as he does the mild outcrossing blood—is more remotely related, if at all, and possesses in his individuality and that of his ancestors the qualities necessary for correcting the small defects transmitted by the preceding sire. When the calves of the second sire approach breeding age, provided the first sire used has proved worthy, it will be advisable in some instances to breed them to him—their grandsire.

In other instances an excellent son of the first sire—out of a highly productive cow possessing no fault in common with the offspring of the first sire—may advantageously be used on the daughters of the second sire. Such is line breeding in the case of the second sire used and line breeding approaching inbreeding in the last two instances suggested.

If the breeder has made no mistake up to this point, and the heifer calves promise to approach the perfection of his ideal, then he is in a position to breed and develop his own bulls and continue line breeding until perfection, as his eye outlines it, has been reached.

The time has then arrived when close inbreeding may be advisable to intensify the blood lines which have attained success, so that the approved type, conformation and production may be retained in the herd. From that time forward line breeding is advisable, foreign blood being introduced gradually and judiciously. Radical outcrossing at this point is absolutely dangerous and excusable only on the grounds of fancy and faddism, for, not knowing how foreign blood is going to nick with the herd, a lifetime of persistent, careful effort may be destroyed by the use of one bull, even though he himself is a good individual and carries blood lines not to be faulted from the standpoint of the family to which he belongs.

Countless other facts pertaining to breeding might well be enumerated, but I have thus far neglected to mention the second phase of my subject—that of feeding dairy cows.

With Proper Breeding Goes Proper Feeding

With the intelligent employment of the breeding principles referred to only meagre results will be accomplished unless equally efficient methods of feeding are followed.

In order that the sire may transmit to the fullest degree his own good qualities and those of his ancestors he must be intelligently fed and managed. A rule followed by most successful breeders is that of keeping their sires in good, healthful condition but on the lean side at all periods so that when the heaviest breeding season arrives they may, by increasing the feed, encourage the bull to be gradually gaining in weight. This strong and most healthful condition materially adds to his prepotency.

Bulls emaciated from lack of nutritious food, or those plethoric because of an over abundance of food and lack of exercise usually beget offspring disappointing to the breeder. Therefore, any system of breeding and management that will provide exercise and keep the sire in reasonable flesh and excellent health is advisable.

It is equally necessary that the females of the herd be properly nourished, not alone for the stimulation of milk and butterfat production but also for the upbuilding of their offspring, the nourishment for which can be secured from no other source than from the mother during the entire period of gestation.

It is a well known fact that the foetus makes its largest growth during the last six weeks of gestation. It is also known that the calf at birth is made up almost entirely of protein, mineral matter and water—there being very little, if any, fat in his body. It is known, in the third place, that the only nutrients in foodstuffs which go to manufacture cartilage, bone, muscle, blood, hair and hide are protein and mineral matter. Therefore, if the ration provided for the mother

is lacking in these essential nutrients, or if she is compelled to continue milking up to freshening time, she must draw upon her own body to nourish the calf, with the result that the future of calves nourished under such conditions is very largely sacrificed before they are born. It is undoubtedly for this reason that calf scours, cholera, pneumonia and the scores of other diseases which play so much havoc on dairy farms exist. They are occasioned by the fact that so few breeders realize the necessity of beginning to feed the calf properly prior to birth. This is one good reason why the cow should be turned dry six or eight weeks before freshening.

While the cow is dry she should be abundantly and judiciously fed, for the following things are required: First, the foetus must be developed; second, the cow's digestive apparatus needs a rest; third, flesh, strength and stamina are to be placed in possession of the cow to enable her to campaign well during the coming period of lactation.

Common sense reasoning in this matter has established a balanced ration, for, in fact, the terms "common sense ration" and "balanced ration" are synonymous. The balanced ration is nothing more nor less than a ration that will accomplish a purpose more efficiently and more economically than any other ration and differs as the purpose desired changes. In other words, a ration balanced for a cow at one period is not a balanced ration for the same cow at another period.

Successful feeding depends upon the ability of the feeder to determine accurately the purposes to be accomplished, and a knowledge of the physical and chemical properties of available foodstuffs that will enable him to combine them that an efficient, common sense, balanced ration results. Thus it is that by analyzing existing conditions a ration at once suitable to developing an unborn calf and conditioning the cow may be formulated. If it be summer time, nothing excels good pasturage or green food as a basic ration, but if in winter, substitutes in the form of corn silage and beet pulp or other succulent food should be used freely in conjunction with some leguminous hay, such as clover, alfalfa, sweet clover, cowpea, soy bean or Canada peas and oat hay.

Whether summer or winter conditions exist, a concentrated ration properly balanced should be fed. Four or six weeks is not a long time, and quick conditioning necessitates a variety of feeds. As a rule, a grain ration consisting of two parts ground oats, one part oil meal, one part bran and one part corn meal will prove efficient. The amount fed daily depends upon the feeding qualities and condition of the cow. As a rule from 6 to 12, or even 16, pounds of the mixture may be fed daily to good advantage. It should be borne in

mind that feed given during the resting period is far from wasted. Even though the cow returns nothing directly, she is making good use of it, and later will return more profit for feed consumed while she is dry than for that eaten at any other period.

As freshening time approaches, if the feeding has been judiciously performed, the cow will begin rounding into bloom and developing an udder to the fullness of her capacity. It is true that more careful attention will be necessitated at freshening than though she were permitted to calve in poorer flesh. Careful and skillful management will suffice to bring her through parturition safely, and every feeder should consider it a part of his education to know how to manage his cows for securing greatest results.

Three days or so before the cow is to freshen her grain ration should be eliminated and in its stead bran mashes composed of three or four pounds of bran thoroughly moistened and well salted should be given at regular feeding hours, in addition to the roughage which, being of a laxative nature, may be continued.

It is never advisable to permit a valuable cow to calve without attendance. If she is a heavy producer under natural conditions, much greater yields may be expected as a result of special fitting. Furthermore, udder troubles and milk fever are more liable to occur. It is quite generally conceded, however, that if feeding operations are such that the cow's digestive tract is kept in a loose, laxative condition and little, if any, milk be taken from the udder, except by the calf, for the first 48 hours, the danger from milk fever is reduced to a minimum. The thought of the careful feeder and herdsman, however, is always of the welfare of his charge, so he will watch her closely day and night until the danger of parturient paralysis has passed, so that, should the slightest symptoms occur, the air treatment may be put to use and sickness forestalled before it has advanced far enough to be weakening in its effect. In case of milk fever all feeding must cease until the cow is again on her feet and quite enough recovered to have regained her appetite.

It is well to leave the calf with its mother the first two or three days, for this assists greatly in relieving the inflammation of the udder and in keeping the cow quiet. As a rule, when 48 hours have passed, if all has gone well, the calf should be taken away, for the mother is ready to begin work in earnest. This is in case the udder has reached normal conditions. Otherwise, the feeding of soft foods, such as bran mashes should continue, and, in addition to frequent application of heat, the udder should be milked out thoroughly many times day and night. This represents much labor, but success in any business is attained only by persistent, intelligent effort and close

attention to details; and he who is most willing and industrious succeeds and leads others to wonder what secrets he practices.

When the cow's condition warrants that she be placed on solid food, haste must be made slowly. Within 30 days she should be on full feed and giving her daily maximum milk yield. Furthermore, she should not be brought to full feed and milk sooner, for at best she is in a weakened condition following parturition.

It is now that the feeder will begin to appreciate the value of the careful and liberal feeding given before freshening, for, in all likelihood, he has been rewarded with a strong, vigorous calf not predisposed to all the ills that affect calves less fortunately born, and he finds the mother strong, fleshy and ready to work. She has much extra fat stored up in her body, and this is well, for, unable to utilize large amounts of food, she at once begins drawing upon the reserve nutrients that are stored, and converts them into milk and butterfat. The purpose of the feeder has changed, and his aim now is to encourage by feed and care the transferring of the fat from the cow's body to the pail. Succulent foods and those rich in protein stimulate milk secretion at the expense of body fat. Therefore, it is well to continue the use of green foods, roots, silage, beet pulp, leguminous hays, and, in addition, a light feed of such protein feeds as bran, oil meal, ground oats and gluten feed.

In the beginning the daily ration should not exceed 4 or 5 pounds, and this should be increased slowly and on alternating days.

All concentrated feed given and all milk yielded should be weighed. No feeder, no matter how experienced, can get the best out of a cow unless by the use of the scales he knows every day the results he has attained that he may use the knowledge on the morrow. Realizing this to be a fact, many successful record makers now provide for each cow on test a box large enough to hold a day's ration and at a convenient time each day her feed for the next 24 hours is weighed and placed therein. This requires a little extra work, but results will pay well for it.

Developing cows is a business, and any business that is worth while is worth doing in an expert manner. By using boxes in this way the 24-hour ration can be divided as best suits the demands of the cow. Some cows eat better in the morning, some at noon and some at night. Often it is found best to give a cow one-half of her entire day's ration at night, leaving the other half to be divided between the next two or three feeds. This can easily be done where the full ration is available.

After the first day's ration has been fed results begin. On the following day the scales will tell the amount of milk stimulated

thereby. On the second day the ration should be increased one-half or three-quarters of a pound, and on the following day the scales should indicate an increase in milk flow, in which case a like increase in feed should be made the fourth day. If the scales do not show an increase in the milk something is wrong. Perhaps the ration is not suited to the particular cow and a change should be made. Thus the ration should be increased by small amounts each alternate day, the scales showing the way on the intervening day. Invariably during the first 30 days a narrow ration—one composed largely of ground oats, oil meal, bran, gluten feed, cottonseed meal, dried distillers' grains, with a very small amount of corn meal in addition to the roughage—should be used, because these are all rich in protein and stimulating to milk secretion.

Greatest results are attained from the feeding that is practiced the four weeks preceding and the four weeks following freshening. If all has gone well, the cow has almost reached the limit of her feeding capacity and the limit of her milk-producing ability at the end of 30 days. A perceptible change has been made in her appearance. Much of the beefy conformation has disappeared and she has taken on a decided dairy form. The surplus fat has been transferred from the body to the pail.

The problem is now to hold the milk flow and the most ideal working form. Recognizing that some foods tend to create energy and fatten the animal when fed heavily enough, and others furnish milk-making nutrients, and that the cow, whatever else she may be, is a machine kept on the farm to convert these foods into milk and butterfat, the feeder with the scales and a variety of feeds can combine and feed them in such amounts as to accomplish any reasonable purpose he may choose if the machine is efficient. From day to day, and from week to week, the ration should be varied gradually, adding to or taking from it the foods of one character, then another; catering always not only to the demand but also to the likes and dislikes of the individual in charge. Great records are never secured by the dozen but by studying and catering to the individual cow.

Anxiety for great records should never tempt overfeeding, though it often does. Many cows are ruined and scores of records made smaller because of too much feed. There is always more danger of overfeeding than of underfeeding, but this danger is greatly lessened where the scales are employed. Many facts pertaining to feeding come from experience, and, though well known to the feeder, are difficult to express clearly in words; but, suffice to say, that in addition to all knowledge known to the art the herdsman must always, with the interest in results, at least keep in mind the condition of the

animal and be prepared to decrease the ration at the first indication of the cow going "off feed." At best cows working hard for long periods tire of their feed and weaken under continued pressure. It is well occasionally to substitute for one feed a bran mash to rest and cool, so to speak, the digestive tract. Any indication of digestive troubles should receive prompt attention and a corrective in the form of raw linseed oil, salts or other laxative given.

The feeder who knows at all times the condition of the animal, the real purpose for which he is feeding and the amount and character of food best suited to accomplish the purpose can safely drive the machine to the limit of its feeding capacity and milking ability.

Statistics show there are, in round numbers, 22,000,000 milk cows on the 6,500,000 farms of this country. They also show the average annual production of butterfat to be less than 150 pounds per cow. There are several reasons why the yield is so low. Of these there are two reasons principally accountable—inefficient cows and improper feeding.

Improving the character of milk cows will increase production to a certain degree temporarily, but assurance of large and permanent betterment necessitates good cows properly fed. Like a great wave, education has spread over every dairy section of this country, showing by conclusive methods the vast difference in the earning power of individual cows. Everywhere the sorting process is in evidence. Meagerly bred and low productive cows are being replaced with superior individuals, and improvement to a large degree is apparent. This procedure is, indeed, commendable and should be persistently and intelligently continued, for, surrounded by conditions of high-priced land, expensive feed and well paid labor, a herd capable of yielding no more than 150 pounds of butterfat per cow annually is not a profitable asset. Even though it were, it would not be an advisable possession, for farm conditions are such in this country that the intelligence of farm operators warrants herds capable of averaging yearly 300 pounds or more of butterfat per cow.

It must be recognized, however, that merely substituting productive cows for nondescripts and purebred dairy sires for scrubs will not bring forth the desired improvements. The most productive herd will revert to the plane of the scrub in production when fed scanty rations composed of unsuitable feeds. Improvement in the dairy herd must be accompanied by skillful, liberal and intelligent feeding if it is to be permanent in character.

Therefore, wise as it is to build up a herd by rational selection and intelligent breeding, the first step should be that of making certain that the present herd is being properly cared for. I doubt not

that the scales and the Babcock test of today are condemning cows when they should be condemning feeders. I doubt not that production in 90 per cent of the herds can be most certainly and rapidly increased by better feeding than by substitution of cows.

So closely hand in hand do selection, breeding, care and feeding go that any one without the others will not insure success. He who is a good feeder and caretaker robs himself if he employs cows lacking in yielding ability. He who is not a good feeder and caretaker robs himself and his cows and has no right to possess animals capable of producing largely.

It has been said that great feeders are born—not made—and that the eye of the master fatteneth his cattle. Truly, the phenomenal butter records that are becoming plentiful nowadays evidence the fact that science and art are possessed by certain feeders. Where ambition exists, any industrious man of intelligence can secure reasonable and very profitable results from dairy cows if he puts into practice the well-known facts pertaining to the feeds he has available and the feeding of them.

There are certain basic principles which must be firmly fixed in the mind of the feeder if he is to stimulate cows to large and economical production. Having determined to manufacture milk and calves, he has become a manufacturer. From a business standpoint his barn is his factory, his cows are his machines and the feeds he chooses are the raw material out of which animal life is to be developed and maintained and from which milk is to be manufactured. This is the true fundamental starting point from which large results, if they are to be secured, must come. It is true that a cow differs radically from a mere machine and demands a different kind of care; but equally is it true that machines differ radically one from another and need radically different kinds of care.

Knowing this, manufacturers familiarize themselves with their machines and give them exactly that sort of care which makes for their greater efficiency.

I know there are eminently successful dairymen and breeders who object seriously to comparing the cow with a mere machine—an inanimate object that does not respond to regularity of care, caresses, comfortable environment and protection from climatic elements. That is because, familiar as they are with cows, they have never considered the machine in the light of one who is as familiar with it as the good breeder is with his cows. He who thus considers the comparison odious does not know that the engine which pulls a train across the continent talks to the engineer. His sentiment for his cows has blinded him to the fact that to accomplish the purpose

the engine eats with even greater regularity than the cow and that the fireman, black and grim with the dust of coal, but with a keen knowledge of the engine's requirements, supplies it with a ration perfectly balanced and abundant, or otherwise, according to whether the iron horse is climbing the mountain side, descending a grade, running on the level or standing still. He has never watched the engineer, as he pulled into a terminal, climb down from his box and view his big horse with pride and address him in terms much more sentimental than the slinging of a milk stool at a cow as she leaves the barn. He does not know how the hostler takes the monster of the rails to the roundhouse and stables it against the elements, nor has he realized how the helper grooms perfectly this great engine and how the machinist doctors its ills that it may be in prime condition to do its very best another day. The story of this great victor of the hills, valleys and prairies is a true story of every machine in the world's great factories; and, were I compelled to tell in a few words how most certainly to double the yield of the American cow, I would say: "Know her purposes, learn her needs and supply them; care for her intelligently, treat her kindly, even as the engineer does his engine and the manufacturer his machine."

I dare say that the greatest of reasons why cows in general do not yield more largely and profitably is because their owners have never viewed them in a really business-like manner. It would seem that, because of sentiment gone astray, the cow is considered as a sort of mysterious being—an animal that has the power to just eat feed, make milk and reproduce at regular intervals her like. Nothing is further from the truth, and cows kept under conditions of such reasoning—or lack of the thoughtful reasoning—produce largely only when sentiment becomes great enough to impel the furnishing of food, care and management, regardless of cost. Then cows seldom produce profitably.

Considered as the most highly developed of machines placed in the barn, which is the factory, the cow is on a definite business basis. It becomes plainly apparent that she is kept for the distinct purpose of converting food, or the raw materials of field and pasture, into the finished commodities—milk, butterfat, offspring and fertilizing material. To do this she must be kept in prime working condition. Proper maintenance is the first essential of success in operating any machine. Therefore, a certain amount and kind of food is necessary for this purpose. To make the commodities desired by her owner additional feeds must be given her, for no cow ever made a pound of milk or an ounce of any other commodity out of anything except food eaten by her at sometime or other.

The manufacturer, who considers himself as such, recognizes that if he is to compete successfully and profitably with his competitors he must not only keep his machines busy; he must provide exactly the character and quality of raw material out of which the finished commodity he would make can be most efficiently and economically made. He, therefore, makes it a large part of his business to familiarize himself with the character, quality and cost of all raw materials available for his purposes. Fortunes have been made through the proper selection of raw materials, and fortunes have been lost through improper selection of raw material. Today, in all parts of the country, dairymen are sacrificing a large percentage of their possible profits because they have not familiarized themselves with the character, quality, composition and cost of feeding values of various foodstuffs which they might better employ than the feeds they are using.

All feeds are composed of identically the same constituents. They differ only as the percentage of these constituents differ, and in their digestibility, palatability, bulk and the physical effect they may have on the animal. Not until the feeder possesses definite knowledge concerning the factors which determine the usefulness of feeds for certain purposes will he be able to determine their relative value or to mix them into an efficient, economical ration for the purpose he would accomplish in keeping and feeding cows.

CHAPTER I.

FIVE THINGS TO CONSIDER ABOUT FEEDS

There are five essential points to be considered in selecting dairy cows. Likewise, there are five essential points to be observed in selecting dairy cow foods. These are palatability, variety, physical character, composition and cost.

Unpalatable rations are wasteful. The cow, non-appreciative of them, eats little more than enough to satisfy the demand of her body, pushes a portion out on the floor to be wasted and leaves the remainder in her feed box to be discarded. Very often cows are considered poor feeders and low producers when, by changing their ration so as to appeal to their appetites, they prove exceptionally productive.

There are reasons to believe that when a cow is compelled to eat food non-palatable to her the secretion of digestive juices is not stimulated to its fullest extent. Because of this, although she may eat a satisfactory amount of food, she will not produce proportionately because a considerable amount of her food passes on undigested and is worse than wasted, since it taxes the organs of digestion without accomplishing any desired purpose.

Cows differ widely—as do all domestic animals, other than the hog—with regard to their likes and dislikes of various foods. What one cow eats with avidity another refuses entirely or eats sparingly. Gluten feed and dried distillers' grain, although recognized as excellent dairy feeds, are disliked by many cows when they are first added to the ration. Most cows acquire a liking for them and soon eat them heartily, but in most herds there are individuals that never learn to appreciate these and other by-products. To such cows it behooves the feeder to give only small portions of these foods with larger portions of those more readily eaten.

Likewise, many other foods are objectionable to certain cows. In fact, few foods are equally acceptable to all. Ground oats are presumably second in palatability only to corn, yet I have in mind one great cow that refused absolutely to eat more ground oats than 1½ pounds daily. In breeding and individuality she gave appearance of being able to make a larger butter record. Her feeder had raised her from calfhood and declared unqualifiedly that 30 pounds of milk daily was the most she would yield. Evidently she was one of those deceitful cows that, judging from her breeding and conformation, should be a great producer, but when put to test would be found

waiting for no apparently good reason. This cow would yield regularly 30 pounds of milk a day, but no amount of effort, seemingly, would induce her to eat food to stimulate a greater flow. After every meal food would remain in her feed box. A happy thought appealed to her feeder. He would find if there were any foods she would eat after satisfying herself with the ration given. Corn meal was offered her. She ate it ravenously. Then, in turn, cottonseed meal, gluten feed, bran, etc., were offered her separately. Each time she displayed her desire to eat. Finally, she was offered ground oats and turned her head away in disgust. The problem was solved. Strange as it may seem, ground oats—one of the greatest and likewise one of the most expensive foods—found little favor with this cow. Oats were omitted from her ration. She ate heartily and increased regularly in her milk flow. When she had been fresh four months she had a butter record of 339.75 pounds.

Her feeder, believing rightfully in the excellence of oats as a food for dairy cows, tried returning them gradually to her ration. He found she would eat 1½ pounds daily with other foods but additional amounts caused her to leave her feed and decline in milk flow.

This presents the first important reason for providing separate and distinct rations for individual cows, and illustrates not only a waste of high-priced feeds but also a diminishing of milk production where but one ration is provided for the herd as a whole. Not in the lifetime of a feeder would he find another cow that would so thoroughly abhor ground oats, but where a large number of foods are utilized seldom would he find a cow that liked all of them equally well. Therefore, upon his ability to determine the most palatable ration for each of his charges depends the greatness of the individual work of each cow, and, in consequence, the greatness and economy of the herd's total production.

The dairyman is willing to pay additionally for a cow of large capacity. He well knows that the only milk he will get is to be made from the food eaten, and, therefore, the more food the cow is capable of eating in a given time the more milk he may expect. Regardless, to a great extent, of her capacity, a cow eats in accordance with the palatability of her ration. It is, therefore, apparent, that, in order to utilize to the fullest degree the inherent digestive capacity possessed by the cow, her ration must be pleasing to her palate.

A most common mistake made by feeders is the utilization of too small a number of foods in compounding rations. A large variety of foods wisely selected insures palatability, economy, efficiency and a balanced ration.

It is absolutely impossible to provide a ration from corn silage,

corn stover, corn meal and timothy hay without the use of other foods. Such a ration is not alone unbalanced, but even though it may be palatable, it lacks in efficiency and is not economical, for it does not provide all nutrients necessary for the manufacture of milk. Even though these feeds are raised on the farm and are cheap in price per ton, he is a most extravagant feeder who depends upon them alone to stimulate large milk production. Indisputable as is this fact, hundreds of thousands of cows in the corn belt are compelled to live and yield as best they can throughout a long winter on such a ration and, working under this as one of their handicaps, thousands of them are being condemned as unprofitable.

In other sections, where corn is not so plentiful, rations consisting of cottonseed meal, bran and leguminous hays are used alone because they are cheaper per ton. A better ration this, but extravagant also because so small a number of foods are used that one does not balance the other. But the feeder who will avail himself of all of these foods and feed them in right proportions will insure such variety for his cows that they will thrive well, keep in good condition, produce to the greatness of their ability and reduce the cost of milk production.

Very often it is possible to purchase efficient foodstuffs cheaply —foodstuffs not palatable in themselves, but that if fed with a large variety of other and more palatable foods can be used to greatly reduce the cost. At the same time, the appetite of the cow will be satisfied and her milk yield increased.

Cows, like people, tire of eating the same ration regularly for a long period of time. A large variety of food makes it possible for the feeder to change the ration often without changing its composition and thereby keeping the cow's appetite keen and her production regular. This suggestion is of especial importance where cows are fed with the desire of giving them large yearly records and when it becomes necessary to encourage them to eat largely and with regularity over a long period.

Master feeders of beef cattle have so recognized the value of variety in their feeding operations that occasionally a radical change is made in their feeding operations. In ripening cattle for the show yard, the beef cattle feeder resorts to feeding his charges four times daily.

For several years it was my good fortune to be associated with Sam Johnson, than whom no man ever more successfully fitted show steers for the International Fat Stock Show. He unconsciously divulged to me a secret. Nearly every Sunday evening, Sam, with the excuse that he should rest a bit on Sunday, would substitute for

the latest evening feed a sloppy bran mash containing a little linseed meal and a liberal supply of salt. This was real variety, and rested the strenuously worked digestive apparatus of each animal. Next morning every steer was waiting at his feed box ready to start anew, and as the week advanced, those great steers, wealthy with flesh and fat, ate well and continued to fatten satisfactorily, looking forward to the coming of Sunday evening, when they would again receive their choice, palatable change of diet.

At first I feared this would not work so well with dairy cows at hard work, but during the St. Louis Cow Demonstration, when much was expected of every cow and when they were being fed heavily, there came a time when they seemed to care little for their feed. When cows on test reach that point it is evident that some change is necessary. I decided Sam had some reason for giving bran mashes other than that he wished a bit of rest on Sunday. Every cow in the herd received an appetizing bran mash the following Sunday evening. A rash experiment, perhaps, but an increased milk flow resulted next morning, and every cow was ravenous for her regular feed. From that time to the end of the test, every cow in the herd received a bran mash in substitution for one regular feed when she evidenced a sluggish appetite. The result was that those cows broke records, and every one left her stall when the test ended in quite as good health and condition as she had ever experienced.

Variety is the spice of the cow's life quite as much as it is of the life of man. He who furnishes his cows an abundance of intelligently selected foods, of a palatable sort, need worry little about balanced rations, for in 99 cases out of 100 the building of a ration from a large number of feeds insures the required nutrients in acceptable proportion. Great as is the assistance realized by a knowledge of food composition, the encouraging of successful production may better be trusted to a man of judgment, balancing rations unconsciously by the use of a large number of foods rather than to a man lacking in judgment balancing a ration with a few foods and many rules.

To work profitably every cow must at all times be in perfect health. Therefore, in selecting foods it is essential that no little consideration be given the physical effect each may have upon the cow.

It is needless to discuss in detail the folly of permitting deteriorated or moldy feed to find a place in the cow's ration. Yet, because moldy silage, heated corn meal and other such inferior feeds do not, as a rule, kill cows, they are often fed when they should be given to the hogs or returned to the land as fertilizer. Very often the digestion of a cow is so interfered with by one feed of spoiled

food that she declines in her milk yield never to return until another freshening period. The profit she would have made is sacrificed in order to save a bit of worthless food. The thoughtful feeder will always discriminate against such food and also against feeding heavily of those which are recognized as harmful to the health of his animals.

All feeds, other than roughages, should be finely ground. There is no reasonable excuse for feeding whole oats, corn or other grains to cattle that are over one year of age. Calves seemingly thrive well on and digest fully whole oats and shelled corn, and there is little doubt that it is more advisable to feed whole grain to them, but when past yearlings the feeding of grain unground is a wasteful process.

Experiments in great numbers prove conclusively that much profit may be secured by grinding grain for cows, and any experienced practical feeder recognizes when he sees whole grains of corn, oats or barley in the excrement that little has been the nourishment extracted from them. The beef feeder may justify the waste by permitting hogs to follow his steers, but even this plan will not excuse the dairyman, because, in addition to the waste occasioned the digestive apparatus—the hardest worked organism of the cow's anatomy—is needlessly taxed. Less regard need be given the digestive apparatus of the steer, for, when he enters the feed lot, he needs digestive organs only for from six months to a year. At the end of that time he goes to the shambles. Let him soak and pre-digest corn for hogs if you wish, but the dairy cow, coming into usefulness as a two-year-old, if she be worthy, has a period of from 10 to 15 years to work in the dairy, and her longevity depends much upon the protection her digestive system receives. Do not demand that she prepare food for hogs in addition to converting tons of food into milk and butterfat, which she does during her lifetime. By grinding her food, great assistance is rendered her and much is saved in the cost of her performance.

A bulky ration is more efficient than a compact one. The cow, having four stomachs, does not digest her food in the same manner as a non-ruminating animal. When she eats she masticates her food very little, swallowing most of it whole. When she finds time she regurgitates and masticates it. This is called chewing the cud. The cow does not, as is sometimes believed, have a regular cud which she chews whenever she so desires, but each of the many cuds she chews consists of food she has eaten at times when she did not feel that she had time to masticate it. During the process of mastication the food is not only reduced to a finer degree, but, even of more importance, saliva is mixed with it. The ptyalin contained in the saliva starts the first process of digestion, that of converting the starches of

the food into sugar. The importance of all particles of food being masticated is apparent, for, unless the starches of the food come in contact with saliva, digestion is incomplete and much of the food is wasted.

A bulky ration is light and easily regurgitated. All portions of it returned to the mouth are masticated, mixed with saliva in abundance and passed on through the regular channels of digestion, where they come in contact with other digestive juices. Compact, heavy rations, when they enter the stomach, are difficult to return to the mouth, and portions of them pass on to the other stomachs without mastication or insalivation. They are, therefore, largely wasted. It is also believed that feed fed in compact form gathers in masses in the stomach so that digestive juices do not percolate thoroughly and quickly among the particles, with a result that none of the nutrients become fully digested. This has been aptly illustrated by placing in one glass jar a quantity of corn meal, in another an equal amount of corn and cob meal and pouring a like amount of water into each jar. After letting both jars stand a few moments and then removing their contents it will be found that the water has fully percolated among the particles of the corn and cob meal, but that only the outer edges of the corn meal are moistened while the inside of the mass is dry. It is for this reason that a pound of corn and cob meal has been found equally as valuable for feeding cattle as a pound of corn meal, and not because the ground corn cob is as valuable pound for pound as ground corn. The value of the cob is almost wholly mechanical. It does not contain any great amount of nutriment.

Because of this knowledge, however, much corn and cob meal is fed in the north and cottonseed hulls in the south, but the advisability of the practice is questionable, except where the ingenuity of the feeder is not such that he can supply bulk in a more valuable form.

The general use of silage is largely solving the problem of supplying bulk to dairy cow rations. Almost everywhere the plan nowadays is to feed the concentrated ration mixed with the silage. This is well, for the particles of grain, adhering to the more bulky and lighter particles of silage, are easily returned to the mouth for mastication and to be mixed with the saliva, thus insuring complete digestion and eliminating waste of food.

A very excellent plan—especially in this day of high-priced bran and oats, one merit of which is the lightness and the bulk they impart to a ration—is to reduce alfalfa hay to quarter-inch lengths and feed in substitution for these more expensive foods. As is well known by dairymen, the dairy cow contest at the St. Louis World's

Fair was conducted on a basis of economy as well as greatness of yield. In the barn over which the writer had supervision of the feeding, it was recognized that alfalfa hay was practically as valuable as bran, which was more expensive. The only problem was how best to reduce it to a form in which it could be fed with the grain ration as bran could be. This was finally done by cutting the alfalfa into quarter-inch lengths each day so it would be fresh, and moistening it with steam or warm water just sufficiently to soften the stems and cause the particles of grain to adhere to the particles of alfalfa. That the plan proved successful is vouched for by the fact that throughout the test every cow received 6 pounds of alfalfa hay mixed with her grain, and very little bran was fed.

The herd in question won both in greatness and economy of production. The cows produced largely because they not only received an abundance of food nutrients, but because the feed was given them in a form easily and readily digested, and the largest possible amount of food nutrients was utilized. They won in economy because the physical and mechanical character of the ration was such that the smallest possible amount of food nutrients was wasted.

Another great advantage of this system will appeal to the feeder striving for much roughage. It will appeal to him that cows will not require such heavy grain feeding to stimulate their largest possible production and that where so much bulk is present it is nearly impossible to overfeed, as is so often the case where concentrates are fed alone.

Where cows become accustomed to rations of this character—and they eat them readily from the beginning—they no longer like to eat dry ground feeds without the cut hay mixed with them. In sections where molasses is a cheap source of nutriment, the efficiency and palatability of such a ration is greatly enhanced including one quart of molasses with each three gallons of water with which the ration is moistened.

CHAPTER II.

COMPOSITION AND COST OF FEEDS

The animal body and all foodstuffs are made of identically the same things. In a broad sense, they are all one and the same thing—food for man or beast. Milk and other familiar foods are fed to calves to grow and develop them to a point where they are slaughtered, retained to reproduce likenesses of themselves or to yield milk—all for the purpose of furnishing food for mankind. We could eliminate the cow entirely, eat the food we give her and receive identically the same food nutrients if cattle foods were equally as palatable, digestible and concentrated in form as are meats and dairy products. Vegetarians do this very largely now, but, even with the growing popularity of cereal breakfast foods, there is no likelihood that the cow will ever be less in evidence than she is today so long as human nature remains as it is.

The great purpose of the cow is not to originate food nutrients. And this she does not do. Her plan is merely to rearrange, according to her own secret formula, the nutrients she finds in coarse, bulky grains and roughages—unpalatable to mankind—and return them in products that are palatable, concentrated and easily digested. The cow is the great transformer that intercedes between nature and man. In return for this, she exacts toll sufficiently large to maintain her life, health and comfort, keep her body in repair and nourish her offspring during the embryonic period. And again, identically the same compounds are required for such maintenance as are found in the composition of food, the animal body, and milk. This fact and the identity of these compounds are illustrated in the following outline:

Food....................	............Protein
Animal Body.............	............Carbohydrates
Milk....................	............Fat
Maintenance.............	............Mineral Matter
	............Water

Expressed in this manner, scientific knowledge is not required to secure a complete, practical, working understanding of food nutrient requirements. It becomes apparent that the animal body, milk and maintenance are not derived from food as such but from the elements of food. Furthermore, the protein, water and mineral matter—found in the animal body, in milk or required for maintenance—are

not and can not be made from carbohydrates or fat, and neither can one be made from the other. Now, reducing the whole problem to a common-sense, practical basis, and stripping it of all fancy, theory and mystery, it ceases to be a bug-bear. Water can be made by the animal out of nothing except water. Protein can be made by the animal out of nothing except protein. Mineral matter can be made by the animal out of nothing except mineral matter.

Water is present in the animal body to the extent of more than 50 per cent, milk contains over 80 per cent and much water is regularly excreted with waste materials. That is why water supplied irregularly or in limited amounts occasions a decrease in milk flow.

In the body of a 1,000-pound cow there are nearly 200 pounds of protein; in 100 pounds of milk there are more than three pounds of protein, and it is a fact that admits of no argument that a cow of the size above mentioned requires .7 of a pound of digestible protein in her food daily to maintain her body. That is why calves fed rations deficient in protein do not thrive; that is why cows fed on such rations, even though fed abundantly, do not produce satisfactory amounts of milk.

Over 5 per cent of the animal body and .7 of 1 per cent of milk are composed of mineral matter. That is why it is especially important that immature animals and cows yielding heavily of milk should be salted regularly and given foods containing a liberal supply of ash or mineral ingredients.

Carbohydrates and fat co-operate with each other. Both are used for the same purpose, 1 pound of fat being equivalent in efficiency to 2¼ pounds of carbohydrates. In fact, the fat contained in a foodstuff is multiplied by two and one-fourth, added to the carbohydrates and considered as a carbohydrate-equivalent in balancing rations. These two nutrients are burned up, or oxidized, by the animal to make heat and energy. A 1,000-pound cow uses 7 pounds of digestible carbohydrates and carbohydrate-equivalents daily just to keep herself in health, comfort and working order. The rest she makes into animal fats, which she places in the milk pail, or, if she is overfed or not given enough protein to balance her ration, she distributes that which she cannot use otherwise through her body, storing it up to be used later. In addition to using 7 pounds of carbohydrates daily for maintenance, the 1,000-pound cow carries an amount of fat in her body varying, according to her condition, from 80 to 300 pounds, and her milk varies in fat content from 2 to 10 pounds per hundredweight, the normal variation being more nearly from 3 to 6 pounds, according, largely, to the breed she represents. Also there is found a very small amount of carbohydrates in the body, and in the form of milk

sugar there are about 5 pounds of carbohydrates in 100 pounds of milk.

From these facts it will be rightfully deducted that of all nutrients this heat energy and fat producer is most largely used. This—and because as a rule in most sections carbohydrates are cheap and most largely found in home grown feeds—no doubt, accounts for the fact that they are very often overfed and wasted. The feeder overlooks the fact that in milk production only that amount which is properly balanced with protein is really serviceable and economical to feed. In fact, although protein is often more expensive than carbohydrates, the dairyman commits a greater extravagance by overfeeding the latter than though he feeds too heavily of the former, because protein that is not used for its own purpose will act in the capacity of carbohydrates, but the opposite is not true.

I am aware that formerly—and to a lesser degree nowadays—practical dairymen and feeders were more or less adverse to suggestions bordering on the theoretical and scientific, and I have treated this subject of composition of foodstuffs in the most practical and briefest manner within my power. I have combined in a few paragraphs what I have learned—from volumes of reading, results of hundreds of experiments and many years of practical experience—to be knowledge absolutely essential for the successful feeder to possess. It must not be treated scornfully by the reader who would profit from the chapters which will follow, for in this age of expensive foodstuffs, with prices fluctuating as they are, no man can secure at once large and profitable production from his cows, quick and cheap growth in his young stock or maintain his breeding herd in healthful and thrifty condition unless he possesses a clear understanding of these facts. The time was when the feeder could scoff at science, refuse absolutely to mix it with practice and succeed fairly well. That was when lands, in virgin fertility, were cheap, stock feed inexpensive, help plentiful and wages low—conditions which do not exist today. Science with practice, and vice versa, is the only rule that leads to successful occupation and away from poverty and drudgery under conditions as they now are and as they will more intensely be ere the youth of today reaches the age of gray hairs.

It is quite as essential that the feeder know the uses of water, protein, carbohydrates, fat and mineral matter in feeding his machines and manufacturing milk, calves and fertilizing ingredients, as for the manufacturer to know the use of iron, steel, copper, brass, tin and wood in feeding his machines and manufacturing gasoline engines, cream separators and manure spreaders. Take me to the factory where the owner scoffs at knowledge, discoveries by honest,

intelligent experimenters and scientists, and we will find the doors closed and locked with no signs other than those of failure in evidence.

Composition of foods as determined by chemical analysis is not the sole factor for consideration. It is not alone important that a food should possess a large content of any desirable nutrient. Only that portion of a food which is digestible is valuable except for giving bulk to the ration. Indigestible materials, after performing the mechanical duty of aiding in the digestion of other portions of the food, are expelled from the digestive tract as waste. It is because of this that young, growing animals and high-producing cows demand concentrated foods in addition to roughages. Rations consisting of an over-abundance of indigestible material satisfy the hunger of the cow and usually furnish her with nutriment sufficient to maintain her body in good form, but, though the cow may be capacious, she is unable to eat an amount of food great enough to secure the additional nutrients necessary to manufacture milk in large quantities. This will be more fully and plainly illustrated in a later chapter.

Cost of milk production depends largely upon the cost of food nutrients. One of the greatest and most prevalent mistakes made by dairymen is that of purchasing foods instead of purchasing digestible nutrients. It is this practice which leads to the continued use of bran in sections where the price has reached $30 per ton, oats that sell for 60c a bushel and timothy hay which for many years has possessed a selling value far in excess of its feeding value for dairy stock. When bran sold for $10 per ton and oats for 10c a bushel, practical experience taught that to mix them liberally with rations increased milk production and that it paid well to feed them. There is no disputing the fact that they are among the most excellent dairy feeds. But, when one familiarizes himself with the fact that a ton of bran contains only 244 pounds of digestible protein, 784 pounds of digestible carbohydrates, 54 pounds of digestible fat, or a total of only 1,082 pounds of digestible material and 72 pounds of fertilizing constituents, it becomes apparent that bran costs too much. Especially is this true if fed with corn and corn silage, when cottonseed meal, a ton of which can be purchased at nearly the same price and contains 744 pounds, 338 pounds and 244 pounds of digestible protein, carbohydrates and fat, respectively, or a total of 1,326 pounds of digestible nutrients and 105 pounds of fertilizing constituents. It is not a difficult matter to make like comparisons of many other foods in demonstration of the fact that the prevailing methods of selecting foods where their digestible composition is not considered is an expensive and extravagant practice. The same reasoning shows it to be advisable to sell

oats and timothy hay at present prices and buy distillers' grains, gluten feed, clover hay and alfalfa to take their places, even disregarding the fact that a more efficient ration is also formulated by doing so.

To provide productive, economical rations for the dairy herd, the feeder must secure the necessary digestible nutrients in a variety of foods that are at once palatable, healthful and comparatively low in price. In determining the composition cost he must base his decision not on the cost per ton of palatable, healthful food alone, but also upon the cost per pound of digestible protein, carbohydrates, fat and mineral matter. No feed is so important that another can not be found that will satisfactorily replace it. Each of these nutrients are so necessary that nothing else can be substituted for any of them without interfering with the condition, health or production of the animal. Therefore, the thoughtful feeder will welcome a discussion of the more common, available foodstuffs, that from among them he may select the most efficient and economical ration possible.

CHAPTER III.

CORN AND ITS BY-PRODUCTS

Corn is the great American crop. From coast to coast and from Canada to Mexico and beyond it is grown with varying degrees of success. Throughout the entire country it can be grown advisedly for feeding purposes. In localities where corn matures with certainty it provides the most economical basis for concentrated rations. Where seasons are too short for maturity to be reached, the entire plant made into silage provides the greatest and most economical source of succulent food nutrients.

Corn, in its various forms, is palatable to all classes of livestock, convenient to feed and usually a home grown product. Therefore, it is the most extensively used foodstuff on the American farm. For the same reason it is the most abused of all foodstuffs. Fed for a distinct purpose, with a knowledge of its limitations as well as of its true value, corn is the greatest and most economical of all foodstuffs. Fed carelessly, without judgment, because it is a home grown, palatable food, corn proves to be the factor that limits production and curtails profits.

Not alone on boards of trade has corn made men rich because they possessed judgment and intelligence, and others poor because they dealt in corn and corn only with recklessness not substantiated with knowledge and judgment. On thousands of farms men have become wealthy by the proper and judicious use of corn in their feeding operations, while others have robbed their lands of fertility and themselves of the profits they should have secured by using up their bountiful crops of corn by reckless, extravagant, thoughtless feeding methods. Not alone is an over-abundance of alcohol distilled from corn harmful to the man who drinks it, but an over-abundance of corn is also harmful to the animal that eats it.

There is no other foodstuff about which the dairyman should know so much as about corn. Because it can be grown on nearly every farm; because it is so palatable in its various forms and stages of growth to all farm animals; because it is so largely digestible; because it is such a cheap source of nutriment; because when made into silage it provides the best and cheapest source of succulence, every dairyman should possess the knowledge which will permit him to make corn the basis of his rations and use it as largely as possible. But because corn does not contain a sufficiency of all nutrients required by the animal; because feeding wholly, or even too largely,

Water,
10.5 pounds.

Dry matter,
89.5 pounds.

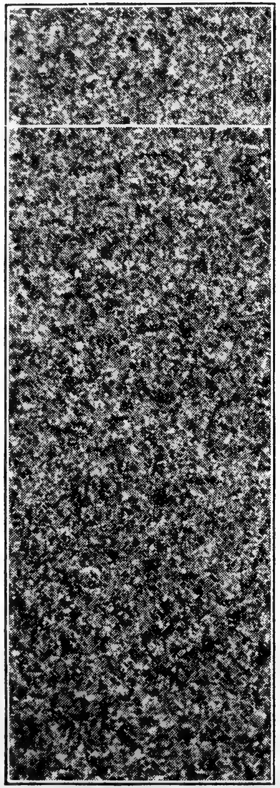

PLATE 1.

Water,
10.5 pounds.

Indigestible
material,
8.1 pounds.

Ash, 1.5 pounds.

Digestible
material,
79.9 pounds.

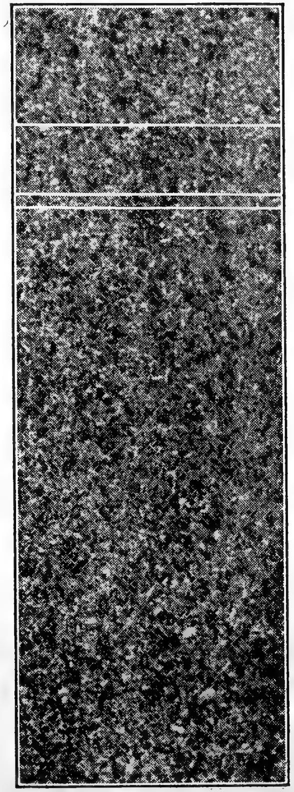

PLATE 2.

Water,
10.5 pounds.

Indigestible
material,
8.1 pounds.

Ash, 1.5 pounds.

Protein,
7.5 pounds.

Carbohydrates,
67.8 pounds.

Fat, 4.6 pounds.

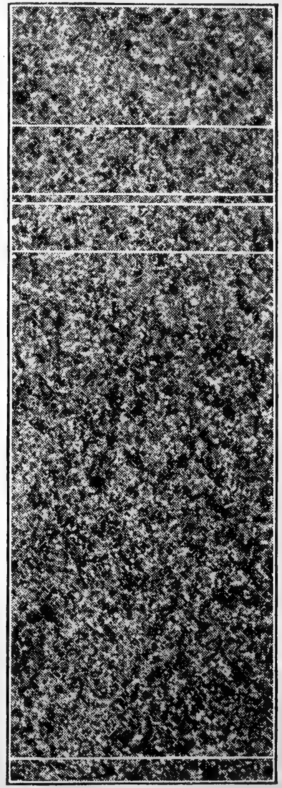

PLATE 3.

of corn limits milk production of cows and growth of young animals; because over-feeding of corn is harmful to the health and breeding powers of animals; because every kernel of corn or pound of silage eaten—after all demands that corn can fulfill have been met—is a sinful extravagance and waste of property, every dairyman should possess the knowledge which will enable him to use corn, not only as largely as possible but in the most economical and profitable manner.

In order to study corn we will take 100 pounds of corn meal and determine its various characteristics. The illustration represents a column of corn meal 27.3 inches high and 12 inches square and is an exact reproduction of just 100 pounds of corn meal.

Our first impression is that 100 pounds of corn meal occupies a comparatively small space. It is not a bulky food. The proportion of water and dry matter is variable according to the sample of feed, but 100 pounds of average corn meal contains 10.5 pounds of water, which merely adds to the bulk, digestibility and palatability of the food. It represents no feeding value. There are 89.5 pounds of dry matter in 100 pounds of corn, and only this needs further consideration.

Of the dry matter 8.1 pounds are indigestible material, in which there is no value other than that of furnishing bulk and adding to the digestibility. This portion may also be eliminated from further consideration. The ash or mineral matter does not undergo the regular process of digestion but passes into solution with the liquids with which it comes in contact in the digestive apparatus. The only consideration needful of mineral matter is, therefore, merely to be assured of its presence in fairly liberal amounts in the final ration. In 100 pounds of corn meal there are 1.5 pounds of ash—not a large amount compared with some foods.

With this elimination of water, ash and indigestible material only 79.9 pounds of nutrients remain for vital consideration. This is divided into three nutrients as shown in Plate 3.

It is very apparent that corn meal is a food especially adapted to furnishing the animal with the material for producing heat, energy and making fat. Calling to mind the fact that 1 pound of fat is equal to and accomplishes the same purposes as 2.25 pounds of carbohydrates, and, compiling the figures, we find present in 100 pounds of corn meal 78.1 pounds of this heat, energy and fat producer. There are only 7.5 pounds of digestible protein present. This is the weakness of corn. It does not supply largely that great nutrient that makes blood, bone, muscle, hair and the casein in milk. By dividing the total of carbohydrates and equivalents by the 7.5

Water, 10.5 pounds.

Dry matter, 89.6 pounds.

100 pounds Corn and cob meal.

Volume, 12x12x30.7 inches.

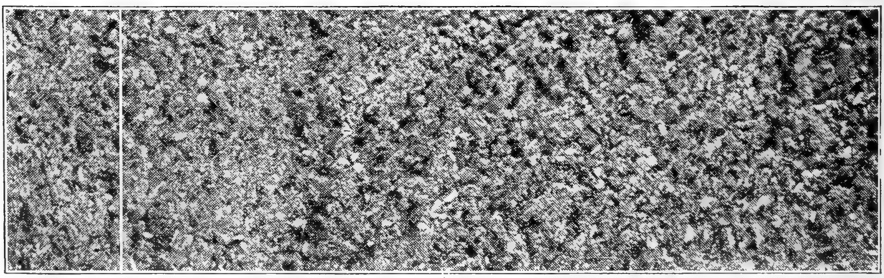

PLATE 4.

Water, 10.4 pounds.

Indigestible material, 14.6 pounds.

Ash, 1.5 pounds.

Digestible material, 73.5 pounds.

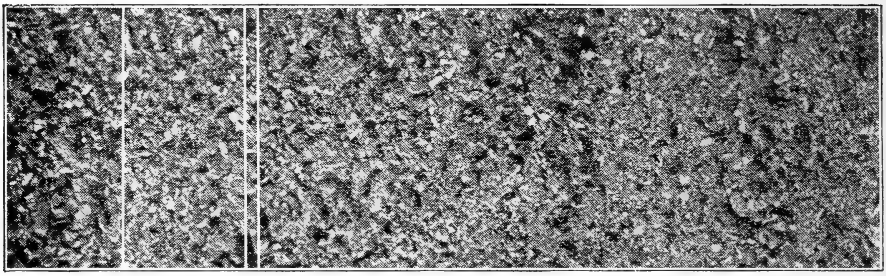

PLATE 5.

Water, 10.4 pounds.

Indigestible material, 14.6 pounds.

Ash, 1.5 pounds.
Protein, 6.1 pounds.

Carbohydrates, 63.7 pounds.

Fat, 3.7 pounds.

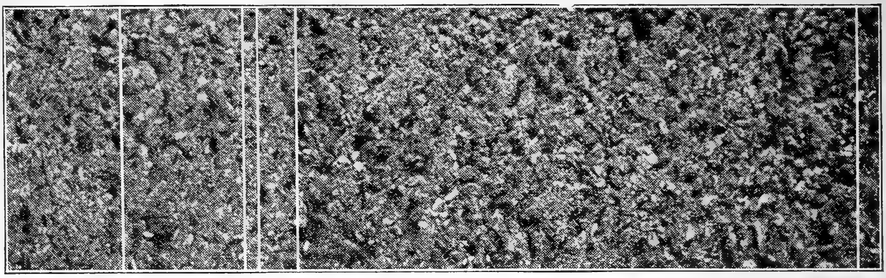

PLATE 6.

pounds of protein in 100 pounds of corn meal, we find 10.4 pounds of the former to 1 pound of the latter. Average milk contains 1 pound of protein to each 3.6 pounds of carbohydrates, so if we were to attempt to make milk with some mechanical machine instead of with the cow, we would look further for material out of which to make it. We could see very plainly that the protein would all be used up long before the carbohydrates, occasioning a big waste of material. Although not to so large a degree, the same reasoning applies to feeding cows for milk production.

Corn and cob meal is more largely used in feeding dairy cows than is corn meal. It has one advantage over corn meal—it is more bulky. Experiments have shown a pound of corn and cob meal equal in feeding value to a pound of corn meal. It is not probable that this would be true if both were mixed with bulky material such as corn silage or chaffed hay, for there is little food value in ground corn cobs—their value is almost entirely mechanical. Realizing this, the thoughtful feeder will eliminate corn cobs from his rations, supplanting them with materials possessing equally great mechanical value and more nutriment, so the cow's digestive apparatus will not be needlessly taxed. In case corn and cob meal is fed it should be very finely ground. This is true of all grains. Feeding whole grains or those coarsely ground is wasteful because a large portion leaves the system undigested.

A comparison of 100 pounds of corn and cob meal with a like amount of corn meal shows the amounts of dry matter and moisture to be practically the same as found in corn meal. The great difference is in the digestibility of the two feeds.

With only 73.5 pounds of digestible dry matter in 100 pounds of corn and cob meal as compared with 79.9 pounds in a like amount of corn meal, it becomes apparent that from every 100 pounds of corn and cob meal the animal must sort out and eliminate from the body 6.4 pounds more indigestible material than though a like amount of corn meal had been fed.

Likewise there is a less amount of each of the essential nutrients present in digestible form. Of these there are 12 pounds of digestible carbohydrate material in proportion to 1 pound of protein—a larger difference even than there is in corn meal.

With a knowledge of the true feeding value of corn and cob meal, and knowing how difficult and expensive it is to reduce cobs to such fineness that they will be readily consumed by the animal, the use of them is to be advised only when other bulky foods cannot be economically provided. This is especially true where cows are expected to yield largely, as when making records.

Feeders in large numbers, having a general idea that corn is the excellent foodstuff that it is, seek no further for knowledge. Some fed whole ear corn, others corn and cob meal and others corn meal. Apparently, good results are obtained. If corn is abundantly fed, calves grow fairly well, cows keep in good condition and produce some milk. The corn is raised on the farm. Its possession represents no direct outlay of money to secure it at the time feed is needed. The process is simple. Following the line of least resistance (and all human nature is prone to do that) we feed corn. Especially is this true where corn is the most plentiful crop grown. Custom, at least, warrants the method. Our fathers and grandfathers, successful farmers in their day, fed that way. Therefore, we are inclined to let well enough alone even though all around us are marked evidences that conditions are radically different than they were even a decade ago.

When corn was cheap, and low prices were secured for cows and their products, a little corn wasted mattered little. There were no great incentives for stimulating large milk production. To make a living on the farm in those days was well, for wealth accrued with the regular and continuous increase in the value of land. Little was the need of considering how large a portion of the corn eaten was wasted by the animal, for it was returned to the fields to make the land richer, anyway.

For some reason or other, men of other lines of business have not been content with this kind of logic. Keen ambition to succeed in a large way, even where close competition does not exist, has impelled them to conserve even the most minute opportunity to add to their profits.

The feeder is not the only manufacturer whose raw material consists of corn. The manufacturers of hominy, brewers' grits, glucose, starch, oil and breakfast foods feed millions upon millions of bushels of corn to their machines. They have studied the kernel of corn more in detail than has the feeder. Their profits are derived from just a portion of that which would be waste were they not closely familiar with composition and nature of the raw material which satisfies the hunger of their machines. They have mechanically divided the kernel of corn and chemically analyzed each part, that they may know which portion is best suited to manufacture the product they desire, and how best and most profitably to dispose of those portions not adapted to their purposes. These studies reveal the picture No. 7.

The outer covering of the kernel, known as the skin, "a," consists of two layers of tough, fibrous material which is not highly

digestible. This is known—and was formerly sold—as corn bran. Like other foods with a large content of crude fiber, one of its chief values is that of imparting bulk to the ration. In furnishing digestible food nutriment, analysis shows there are in 100 pounds of corn bran, 7.4 pounds of protein, 59.8 pounds of carbohydrates, 4.6 pounds of fat and 1.3 pounds of ash. Corn bran is seldom sold as such nowadays, being used to add bulk to other commercial feeds and decrease their cost per ton. It thus serves as a useful filler.

Immediately under the bran of the kernel is located the gluten, "d." As the bran is rich in crude fiber, so is the gluten rich in protein, for which reason it recommends itself highly as an animal food. The lower end of the kernel, "b," is largely occupied by the germ which contains some gluten but is more largely oil. The remainder of the kernel, "c," or about 84 per cent of it, is starchy material. Primarily, this is the part the manufacturers of brewers' grits, hominy, glucose and starch are desirous of securing. To them the remainder of the kernel is waste except as they utilize it for other products and for by-products.

The process of separating the various parts of the corn is simple and mechanical. Briefly, the kernels are ground, either before or after soaking in water, and then passed through a series of troughs filled with water. The bran, which is the lightest, immediately rises to the top, and the germs which are heaviest, settle to the bottom. Starch and gluten remain suspended in the water, their separation being more retarded. In time the starch settles and the gluten floating on with the water is finally recovered to be made into gluten meal.

Although not entirely accurate, the process illustrates the manner in which the animal divides the kernel during the process of digestion and assimilation. Also in this division the feeder has an excellent example of the proportionate amounts of bulky material, ash, protein, carbohydrates and fat as they exist in the kernel of corn.

Like the mechanical machine, the cow when fed whole kernels of corn subjects them to a soaking process in her first stomach, which is termed her paunch or rumen. When thoroughly soaked, she regurgitates and grinds them, but not as thoroughly as does the mechanical machine, as is evidenced by the large number of whole kernels excreted in the manure. When ground, the corn is again swallowed and starts on its trip through the stomach and the intestines. Digestion and assimilation begin at once. From the bran is taken the soluble ash, or mineral matter, to build up the mineral content of the blood, to make bone and to furnish the required amount of ash in the milk. From the gluten the protein is taken and distrib-

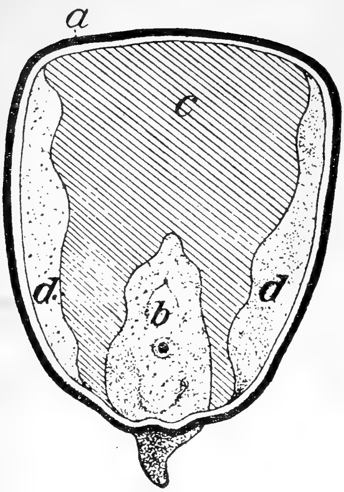

PLATE 7.
a—covering. b—germ. c—starch. d—gluten.

Water,
9.1 pounds.

Dry matter,
90.9 pounds.

PLATE 8.
100 pounds gluten meal—exact volume, 12x12x20½ inches.

Water,
9.1 pounds.

Indigestible material,
10.3 pounds.

Ash, 2.1 pounds.

Digestible material,
78.5 pounds.

PLATE 9.
100 pounds gluten meal—exact volume, 12x12x20½ inches.

Water,
9.1 pounds.

Indigestible material,
10.3 pounds.

Ash, 2.1 pounds.

Protein,
30.2 pounds.

Carbohydrates,
43.9 pounds.

Fat, 4.4 pounds.

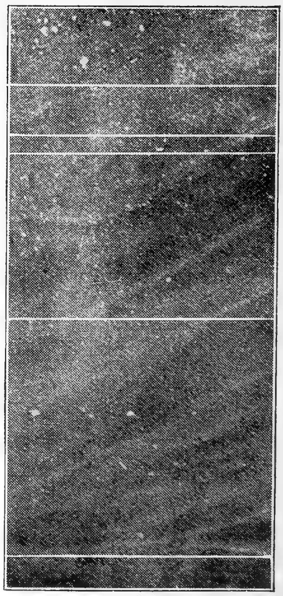

PLATE 10.
100 pounds gluten meal—exact volume, 12x12x20½ inches.

uted to the parts of the body where it is needed. From the germ fat is extracted and from the starchy part carbohydrates are secured to be absorbed by the blood and carried to all parts of the body. The indigestible materials of each of these component parts of the kernel pass from the digestive apparatus and are expelled from the body as waste. Thus it is seen that the kernel of corn contains all nutrients demanded by the animal, and, were it strictly, instead of illustratively, true that bran is mineral matter, gluten is protein, the germ is fat and the starch is carbohydrates, and could each readily be separated from the other, it would be easy to balance the concentrated ration by merely eliminating from corn an amount of the starch sufficient to secure the most desirable proportion of protein to carbonaceous material. As this is impossible, or at least impractical, the thoughtful breeder increases the protein content of his rations by raising and buying foods rich in protein instead of decreasing the carbohydrate content of corn and selling starch. Even were the former plan possible, the latter plan would be the more advisable, for variety —an essential factor in formulating rations—is assured by its use.

Because of this and because the by-products of corn are among the most useful protein carriers, a study of them is interesting and necessary to the dairyman who would secure large and economical results. Especially should the feeder of the corn belt consider seriously the use of corn by-products, for in accordance with the demand for and the price of these by-products, the price of the corn he raises and has for sale varies.

Gluten meal is a concentrated feed. Being kiln dried, it contains less moisture in proportion to the dry matter than does corn meal, and, as the accompanying cut illustrates, it is one of the least bulky of feeds.

Because gluten meal is so concentrated, it naturally follows that it is rich in the various feeding nutrients; and, furthermore, because it lacks bulk and, to a degree, palatability, it should not be fed alone but with other foods of a more bulky nature.

It has been shown how the crude fibre, and, therefore, the larger part of the indigestible materials, were eliminated from the corn kernel with the bran. Therefore, gluten meal contains a large percentage of digestible material as plate No. 9 shows.

Regardless of what nutrients gluten meal contains, the mere fact that in 100 pounds there are 78.5 pounds of digestible material shows it to be worth more per ton than corn meal—100 pounds of which contains only 79.9 pounds of material that is digestible and of which the animal can make use.

But it has been seen that the gluten meal is the protein part of the corn grain, and Plate 10 shows it to be rich in this essential nutrient.

Not alone is gluten meal rich in protein. It contains 4.4 pounds of fat in each 100 pounds. Each pound of fat being 2¼ times as useful as carbohydrates, and there being 43.9 pounds of this latter nutrient present, multiplication and addition reveal the fact that gluten meal contains a total of 53.8 pounds of energy-producing value as compared with 79.05 pounds contained in corn meal. Gluten meal contains 2.1 pounds of ash per hundredweight, practically the same amount as corn meal.

Gluten meal fed alone would be considered a very narrow ration, for it contains 1 pound of digestible protein to 1.9 pounds of digestible carbohydrates and their equivalents. Dairymen who have used gluten meal can vouch for its value where it is fed with foods of a more bulky nature that are lacking in protein and fat. Experiments performed at many stations verify the fact that it is as valuable as its favorable analysis implies. It has been demonstrated that it is equal to cottonseed meal and that a ration consisting of corn meal, bran and gluten meal is at least 10 per cent better for stimulating milk production than is a ration consisting of corn meal and bran only.

That gluten meal is a valuable food for cows is a fact. The extent with which it should be used depends upon its cost per ton as compared with other protein foods, a factor which will be discussed in a later chapter.

Gluten Feed and Germ Oil Meal

Gluten feed is gluten meal plus corn bran. It is, therefore, less concentrated, less digestible and lower in feeding value than gluten meal and of much greater feeding value than corn bran. There are two distinct reasons why gluten feed is more largely used than gluten meal.

In the first place, corn bran is so low in feeding value that feeders discriminate against it. It is a by-product difficult to sell. To rid themselves of it at a fair price, manufacturers mix it with the meal forming gluten feed and the feeder purchases it readily in this disguised form.

In the second place, under the majority of conditions feeders secure equally as good, if not more satisfactory, results from the feed than they would from the meal. This is because many feeders are careless and wasteful in their feeding operations. Gluten meal being more concentrated, there is more danger of over-feeding animals with it than there is with gluten feed. Being more expensive, wastes are

more costly and, naturally, where careless feeding methods are employed it is more difficult to secure economical results. It is especially feasible to use the feed, in preference to the meal, in sections where carbohydrates are nearly or quite as expensive as protein; also where a small rather than a large variety of foods constitute the ration.

In the hands of the expert feeder gluten meal is usually the cheaper source of feeding nutrients. Such a feeder mixes several foods in a careful, intelligent manner that insures palatability, bulk, digestibility, variety and a right proportion of the essential nutrients at the least cost. Although gluten meal costs him more per ton, the rule is that he secures digestible nutrients, especially protein, cheaper per pound than in gluten feed.

This, however, depends upon the relative price per ton, and occasionally the reverse is true, in which event the feed is used in preference to the meal.

The feeder must always keep in mind the fact that he is striving for both large and economical results and judge between feeds accordingly. This does not imply that he can always base his determinations upon feed analysis, because experiments and experiences indicate that in certain instances foods lower in analysis produce better results than other foods which, from the chemist's standpoint, should prove superior. This can hardly prove true with regard to gluten feed as compared with gluten meal, however, because they are so nearly analogous in physical characteristics, both being by-products of corn.

Gluten feed, like gluten meal, is a kiln-dried product and, therefore, contains about the same proportionate weight of water and dry matter. Because of the presence of bulky corn bran gluten feed is the more bulky, and the greatness of the bulk as well as the feeding value depend to a very large degree upon the percentage of bran present in proportion to the amount of meal.

Plate No. 12 illustrates the amount of ash or mineral matter contained in 100 pounds of gluten feed and also indicates the relative amounts of digestible and indigestible material. A comparison of this with plate No. 9 impresses one with the fact that even though the feed contained equally as large percentages of total nutrients as the meal, it would not be as valuable a food because of the greater amount of indigestible material, which is valuable only as it adds to the bulkiness of the ration.

Because of the fact that both gluten feed and gluten meal are purchased more largely for furnishing protein, plate No. 13 will prove especially interesting. It demonstrates clearly the position

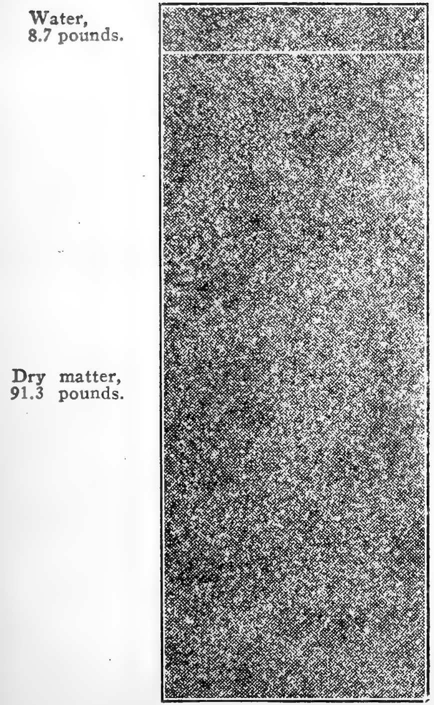

PLATE 11.
100 pounds gluten feed—exact volume, 12x12x24.6 inches.

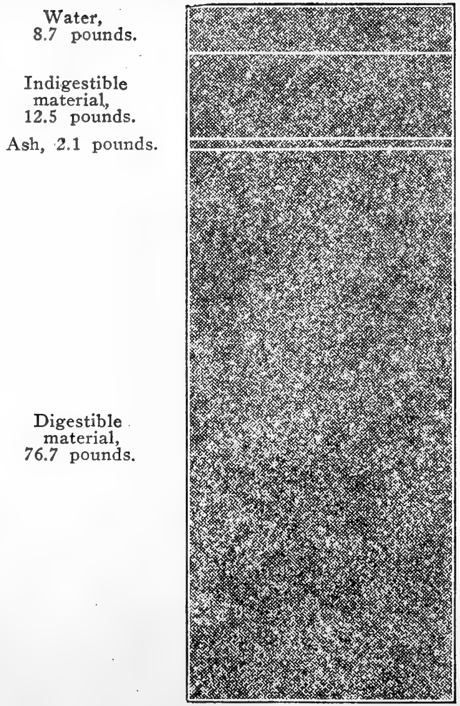

PLATE 12.
100 pounds gluten feed—exact volume, 12x12x24.6 inches.

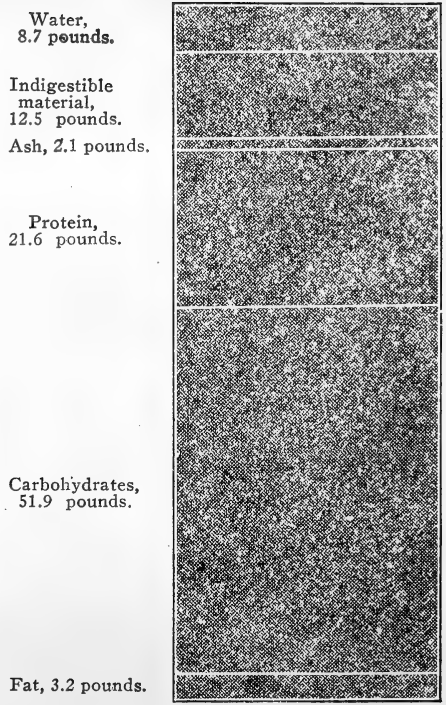

PLATE 13.
100 pounds gluten feed—exact volume, 12x12x24.6 inches.

gluten feed holds as a source of feeding nutrients. By comparing this with plate No. 10 the reader will secure an accurate idea of the relative value of the two corn by-products. Because it ranks considerably lower than gluten meal, the conclusion should not be drawn that gluten feed is not a valuable food for stimulating milk production. On the contrary, it ranks among the best of foodstuffs and is used by dairymen, by breeders, and especially by those who are striving to make large milk and butter records in all parts of the country where the securing of protein is a problem.

As previously indicated, it is a safer food to use than gluten meal, and where its cost permits and conditions demand, it may be fed as largely as five, six, or even eight, pounds daily mixed with other feeds without injuring the cow. It should not be fed heavily to cows just before and immediately following calving, or to cows affected with udder troubles, for when corn meal and gluten feed are fed heavily inflammation and other udder troubles are aggravated. Cows not accustomed to gluten do not find it palatable probably because of the slight percentage of acid remaining as a result of the process of manufacture, but, after becoming accustomed to the taste, they eat it with avidity. Because of this it should be added to rations in small amounts and gradually when its use is first begun. Used judiciously both gluten feed and gluten meal are valuable to use with carbonaceous foods for furnishing protein in digestible form, and I do not hestitate to recommend their use when prices, compared with prices of other protein foods, warrant it.

From the germ of the corn oil is extracted and a residue remains. This is termed germ oil meal. It is another valuable by-product of corn. This fact has been recognized for many years by breeders of swine, but dairymen have been slow to utilize it in their feeding operations. This is, no doubt, due to the fact that teachings pertaining to the compiling of dairy rations have so persistently advocated the purchasing of foods on a protein basis that the value of carbohydrates and fat has been, to a large degree, overlooked. Conditions vary so greatly from year to year, however, that the feeder who realizes the true merits of all foodstuffs can very often well afford to use feeds that in other years he would find by comparison to be over-expensive. Furthermore, the feeder of the south, where cottonseed meal is plentiful and cheap; the feeder of the west, where alfalfa is often a drug on the market, and the feeder of the east, who finds carbonaceous foods almost, if not quite, as expensive as protein, will as a rule find germ oil meal a most advisable source of essential food nutrients.

Water,
8.9 pounds.

Dry matter,
91.1 pounds.

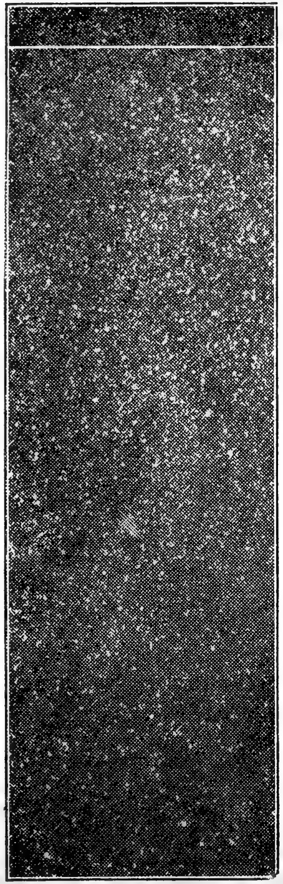

PLATE 14.
100 pounds germ oil meal—exact volume, 12x12x30.7 inches.

Water,
8.9 pounds.

Indigestible material,
18.9 pounds.

Ash, 2.7 pounds.

Digestible material,
69.5 pounds.

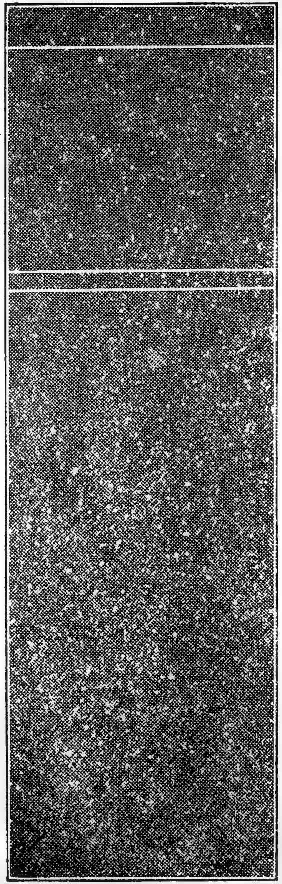

PLATE 15.
100 pounds germ oil meal—exact volume, 12x12x30.7 inches.

Water,
8.9 pounds.

Indigestible material,
18.9 pounds.

Ash, 2.7 pounds.

Protein,
16.5 pounds.

Carbohydrates,
42.6 pounds.

Fat, 10.4 pounds.

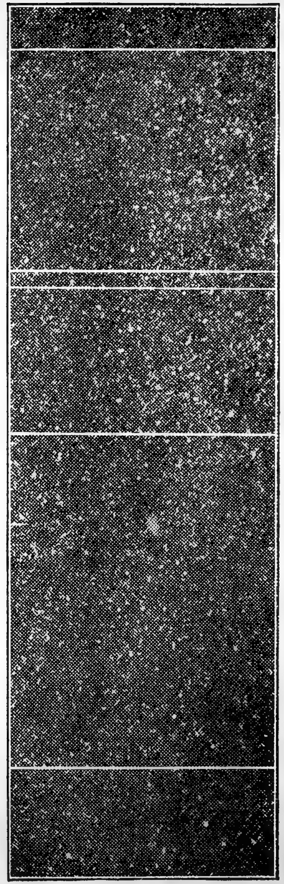

PLATE 16.
100 pounds germ oil meal—exact volume, 12x12x30.7 inches.

This winter, even throughout the corn belt, the dairyman has been able to purchase all nutrients in germ oil meal cheaper than in corn meal. We have fed many tons of it with most excellent results in maintaining condition of animals and stimulating economical milk production.

Like other kiln-dried commercial foods, germ oil meal contains a low proportion of moisture, and here is its first value over corn meal.

Germ oil meal compares favorably in its content of ash and digestible material with corn meal as illustrated in plate No. 15.

Analysis shows germ oil meal to contain more digestible protein and fat than corn meal and only 3 per cent less carbohydrates. By reducing the fat to terms of carbohydrates the fact is revealed that germ oil meal is nearly equal to corn meal in energy values. As a matter of fact, experience will demonstrate this by-product to be at least equal to corn meal and a comparison of plates No. 16 and No. 3 will show how closely they compare in feeding nutrients.

This winter there has been a difference of from $4 to $6 per ton in price between corn meal and germ oil meal in favor of the latter.

Because of the high content of fat left after the oil has been extracted from the germ, the concensus of opinion has been that germ oil meal is not safe to feed in large amounts. To determine this point we have this year fed as high as five pounds daily to individual cows with excellent results and no apparent ill effects.

In the fall, germ oil meal usually sells at a very reasonable price—in fact, so reasonable that dairymen can afford to sell corn and invest the proceeds in it and furnish additional variety to the rations, at the same time reducing their cost and increasing their efficiency.

Another distinct and favorable point is that the oil contained in germ oil meal adds to the ration to a large degree the physical value furnished by linseed meal and may be substituted for a portion of this much more expensive by-product.

While germ oil meal remains low in price, the dairyman can well afford to join the swine breeder in utilizing it in compounding rations for large and economical production and for maintaining a most desirable condition in his animals.

Hominy Feed

"Now," said Mr. Jones, energetically, "I think it's high time, Jimmie, that you began to learn something, and I am going to teach you, so we will begin by counting the people in our family."

"Yeth, thir," said Jimmie.

"Now, mother is one, and I am one, so that makes two, doesn't it?"

"Yeth, thir," said Jimmie.

"And grandma is one more, and she makes how many?"

Jimmie looked interested, but doubtful.

"Three, isn't it?" prompted father.

"Yeth, thir," said Jimmie.

"And, now, there's grandpa. He makes—how many? Four, isn't it?"

"Yeth, thir," said Jimmie.

"And there's Aunt Ellen. She makes—how many? Five, isn't it?"

"Yeth, thir," said Jimmie.

"And, then, there's Uncle Stephen. He makes—"

"But, daddy," exclaimed Jimmie, "do they all make hominy?"

Making hominy and brewers' grits is an industry of large dimensions in the corn belt. Large breweries use grits by trainloads, and the extensive use of hominy is well known. Hominy and brewers' grits are made in quite the same manner. Kernels of corn are soaked and while soft the bran and germ, with the starchy material that adheres to them, are removed. When these are ground and kiln-dried they are known as hominy feed or hominy chop.

More nearly than any other by-product hominy feed resembles corn meal in its analysis and feeding qualities. No doubt that is the reason why feeders in general are not more familiar with its use. So great has been the tendency on the part of the educators to base feed values on the content of protein that many very useful feeds have been given little consideration. To do this is to assume that carbohydrates are either always of such abundance or so cheap in price that they deserve little consideration. This is wrong, for in many sections cows are being fed rations not only deficient in carbohydrate materials but over-balanced with protein because carbohydrates are available only in feeds that are high in price. The truth of this is exemplified by the fact that right now the feeder, located in the heart of the corn belt where corn is cheaper than any place else on earth, can purchase carbohydrates and their equivalents cheaper in the form of hominy feed than he can in corn meal. It is true that prices for corn are exceptionally high this year, but as a rule hominy feed is practically as cheap a food as corn meal.

For feeding dairy cows it is equal to and by many feeders considered superior to corn meal. By way of supplying variety and bulk to the ration, the rule is that a portion of the corn raised on the farm can well be sold and the proceeds invested in hominy feed.

Being a kiln-dried product hominy contains only 9.6 pounds of moisture; therefore, more dry matter than corn meal, as plate No. 17 shows.

This is a point not alone favorable to its feeding value but also to its keeping qualities. Because it can be kept indefinitely under ordinary storage conditions, it can be purchased in wholesale lots at a considerable saving to the feeder. This is not true of corn meal which in hot weather molds if stored in large volumes.

It is well to give consideration to the exact moisture in all kiln-dried foods, though, for unless thoroughly dried the manufacturer will profit at the expense of the feeder and the keeping qualities of the product will be less stable.

Because a large percentage of the starch or heavier part of the corn has been eliminated there remains a larger percentage of bran. Therefore, hominy feed contains a larger percentage of indigestible material and much more ash than corn meal.

Strange as it may seem, there is also practically as large a content of digestible material. This is made possible by the lower percentage of water. Because of these conditions hominy feed is much more bulky than corn and quite as palatable.

Thus far the reader will agree that as a substitute for corn meal it is advisable to use hominy feed when prices favor, because it is a superior feed, as comparison of plate No. 18 with plate No. 2 will show.

From the standpoint of digestible nutrients, hominy feed is again slightly better than corn meal. It contains slightly less protein, but the reader should not think of hominy feed as a protein feed. It is not. When used as corn meal is used it should be supplemented with foods rich in protein, there being only one pound of this essential nutrient to 11 pounds of carbohydrate material.

In carbohydrates corn meal leads with 67.8 pounds per hundredweight as compared with 61.2 pounds in a like amount of hominy feed, but in fat content the latter food contains so great an amount that after reducing to carbohydrate equivalents in both cases it is found that 100 pounds of hominy feed contain practically the same amount of the energy-producing material.

Thus it is found that in every respect hominy feed ranks well with corn meal from an analytical standpoint.

"The proof of the pudding is in the eating." The final question is: What are the results secured by practical feeders? Mere analysis, valuable as it is, does not always portray the whole truth relative to a foodstuff. Sometimes the practical feeder secures results from feeds not accounted for by analysis, and at other times his results are less favorable than analysis indicates they should be.

Water,
10.1 pounds.

Dry matter,
89.9 pounds.

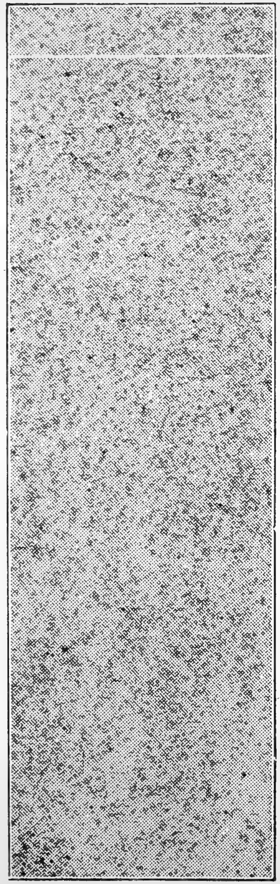

PLATE 17.
100 pounds hominy feed—exact volume, 12x12x30.7 inches.

Water,
10.1 pounds.

Indigestible material,
11.8 pounds.

Ash, 2.6 pounds.

Digestible material,
75.5 pounds.

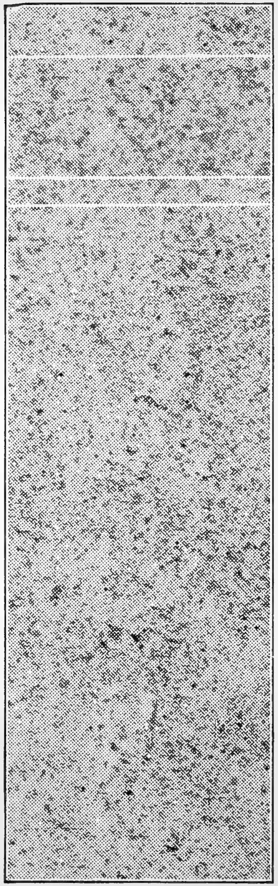

PLATE 18.
100 pounds hominy feed—exact volume, 12x12x30.7 inches.

Water,
10.1 pounds.

Indigestible material,
11.8 pounds.

Ash, 2.6 pounds.

Protein,
7 pounds.

Carbohydrates,
61.2 pounds.

Fat, 7.3 pounds.

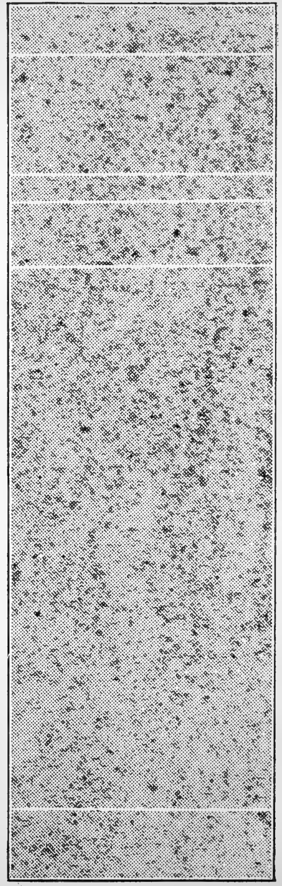

PLATE 19.
100 pounds hominy feed—exact volume, 12x12x30.7 inches.

Hominy feed lives up to the chemist's recommendations. It is used largely by feeders of record cows in substitution for corn meal either in part or entirely. In the parlance of the feeder, "it is not so heating as corn meal." This is because it is more bulky. It has less tendency to injure udders when fed heavily and cows remain on feed more steadily when it is used. Our own experience indicates that it is equal, pound for pound, to corn meal, and today we can purchase it for $2.50 per ton less. We feed no corn meal.

CHAPTER IV.

WHEAT AND ITS BY-PRODUCTS

Wheat, being considered superior to corn for human food, is not so generally available for stock-feeding purposes.

There are sections, however, where wheat is grown almost to the exclusion of corn, and in such places it sometimes proves a more economical source of feeding nutrients, especially carbohydrates. It is not the rule, however, even where wheat is abundantly grown, that the higher class grades can be considered favorably for feeding dairy cows. On the other hand, there is always much wheat that, from a commercial or milling standpoint, will not command top prices. For feeding purposes these lower grades are practically, though not quite, as valuable as are the higher grades and can usually be purchased at a price which warrants their use in feeding dairy animals. For this reason dairymen in sections where wheat is largely grown should familiarize themselves with its feeding value.

Wheat, like corn, is a carbonaceous food. Its use, therefore, demands an addition of foods rich in protein for the stimulation of large and persistent production.

Although, as is shown by Plate 22, wheat contains less fat than corn, it ranks higher in carbohydrates, protein and mineral matter. More than this, the mineral matter consists more largely of phosphorus and potash than does the mineral matter contained in corn. This and the larger content of protein would favor wheat; but experiments of a practical nature conducted to determine the relative value of the two indicate that the feeder is justified in considering them equal, pound for pound, in feeding dairy cows.

For young and growing animals, wheat has an advantage over corn because of the importance of potash, phosphorus and protein in developing bone and muscle. With these facts in mind it is easy to decide whether the feeding of ground wheat to dairy cows is advisable.

If the feeder finds available discolored wheat, or that which will not grade high because of an over-abundance of shrunken kernels, and it can be purchased a trifle more cheaply than corn or other feeds which supply carbohydrates, then it will be more profitably to feed it to dairy cows than to market it.

Furthermore, there is always present in wheat a sufficient amount of shrunken kernels, chaff and weed seed so that the wheat farmer can well afford, under ordinary conditions, to clean his wheat

and offer for sale only the choicest grade and retain on his farm the remainder of the crop for feeding purposes. A sufficiently higher price per bushel will be secured for the better grade so that when the feeding and fertilizing values of what remains on the farm are considered more profit from the crop will be secured, the wheat farmer will find employment for the winter months, and his farm will be kept in a higher state of fertility.

Because wheat farmers have not recognized these facts, millers have profited. Wheat is purchased at a lower price because it will not grade high. By a simple mechanical process the millers take from their purchases, gathered from large areas, the weed seeds, chaff and inferior kernels, leaving wheat of the finest quality to be resold or ground into flour and by-products.

That which they take out is sold as screenings. The feeding value of screenings depends upon the percentage of wheat present as compared with weed seed and foreign products. Because this proportion varies so greatly a definite feeding value cannot be placed upon wheat screenings. Nevertheless, these screenings find a large demand among manufacturers of mixed commercial feeds. This is not a reflection on the feed manufacturer, for there is present in these screenings valuable feeding nutrients. It is fortunate there is a market for them in view of the fact that the wheat raiser has been in the past, and is yet, overlooking almost entirely his great opportunity for providing himself with one of the most valuable feeds for dairy animals and other livestock.

In sections where wheat is not extensively grown it is true that dairymen can purchase wheat screenings at reasonable prices. Whether this is advisable depends upon the ability of the dairyman to estimate the value of screenings, for this differs very greatly, according to the amount and character of the weed seeds and chaff present. In any event whether the screenings are raised on the farm or purchased, they should be finely ground in order to be readily digested and to eliminate the danger of introducing or perpetuating vicious weeds.

Wheat is so largely used for milling purposes that dairymen are not so much interested in the value of the whole kernels for feeding purposes as they are in the by-products. In the manufacture of flour the miller tries to secure as large a milling percentage as possible of high-grade white flour because from this source he secures his highest prices. If two-thirds of the wheat mills into flour of high grade, he has performed his duty efficiently.

For flour purposes he uses only the inner part of the kernel, which consists of the starchy and glutenous parts. That which re-

Water, 10.2 pounds.

Dry matter, 89.8 pounds.

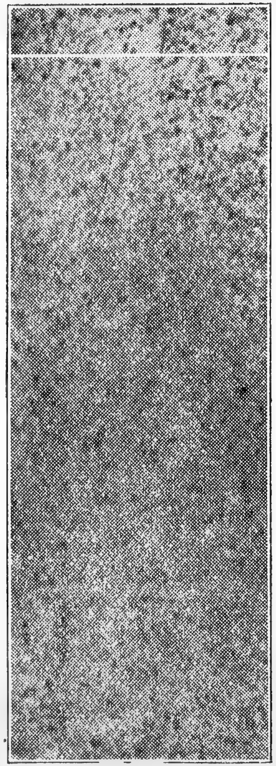

PLATE 20.
100 pounds ground wheat—exact volume, 12x12x26.35 inches.

Water, 10.2 pounds.

Indigestible material, 9.7 pounds.

Ash, 1.9 pounds.

Digestible material, 78.2 pounds.

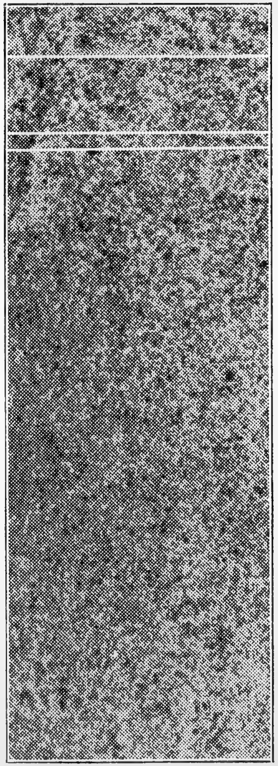

PLATE 21.
100 pounds ground wheat—exact volume, 12x12x26.35 inches.

Water, 10.2 pounds.

Indigestible material, 9.7 pounds.

Ash, 1.9 pounds.

Protein, 9.2 pounds.

Carbohydrates, 67.5 pounds.

Fat, 1.5 pounds.

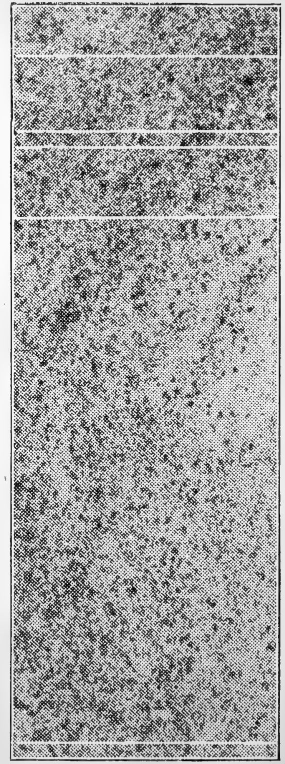

PLATE 22.
100 pounds ground wheat—exact volume, 12x12x26.35 inches.

mains is the four outer layers, or coverings of the kernel and the germ. To the dairyman the four outer layers are of greatest importance, for these are represented by bran.

Sometimes the germ is milled with the flour, in which event a darker product results, which is not favorably accepted for human food. This is known as low-grade flour and is largely used for feeding purposes.

Usually, however, the germs are mixed with the finer particles of bran and the small particles of flour and sold as middlings.

Very often the term middlings and shorts are considered by the feed dealer as synonymous. Strictly speaking, however, shorts are less valuable than middlings because they consist of reground bran and the dirt and sweepings from the mill. Because the terms shorts and middlings conflict in so many instances they will be treated as one by-product in this discussion with the suggestion that, if either is used by the reader, he determine before purchasing that the product he is securing is really middlings and not mill sweepings.

Owing to the fact that it is estimated that there are approximately 5,000,000 tons of wheat products produced in the United States annually, the following discussions pertaining to them will be of special interest to the breeder, for it is worth his while to have a well defined knowledge of their feeding value.

Low Grade Flour

It is sometimes possible to purchase low-grade flour at a price in keeping with its feeding value. Under such conditions its use is advisable in a limited way. Because of its concentrated form, however, and because of the pasty, sticky mass it makes when mixed with saliva, it must be mixed with other concentrates in order to be palatable or successfully used. From the standpoint of analysis alone, low-grade flour is a feed almost perfectly balanced for milk production. It contains one pound of digestible protein for each four pounds of digestible carbohydrates and carbohydrate equivalents. It, therefore, provides a most excellent example of the fact that theory alone will not suffice in feeding animals successfully. The observance of practical results is essential. In the face of the fact that low-grade flour analyzes so excellently as a concentrated ration, there are three reasons why it cannot be used alone for feeding dairy cows.

First, it is usually too high in price to constitute an entire concentrated ration. Second, because of its unpalatable nature when moistened with saliva, its use to the exclusion of other feeds is not practical. Third, it is not sufficiently bulky.

Water,
11.1 pounds.

Dry matter,
88.9 pounds.

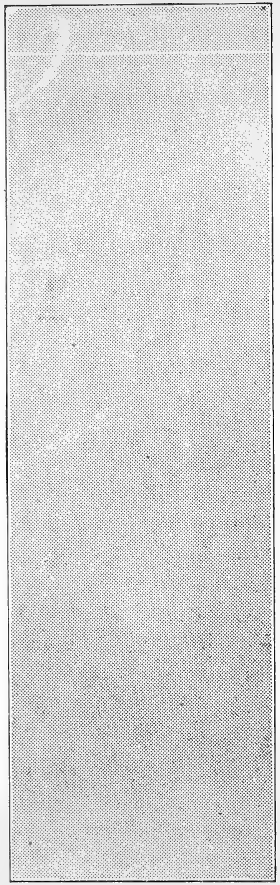

PLATE 23.
100 pounds low grade flour—exact volume, 12x12x30.73 inches.

Water,
11.1 pounds.

Indigestible material,
11.6 pounds.

Ash, 2.5 pounds.

Digestible material,
74.8 pounds.

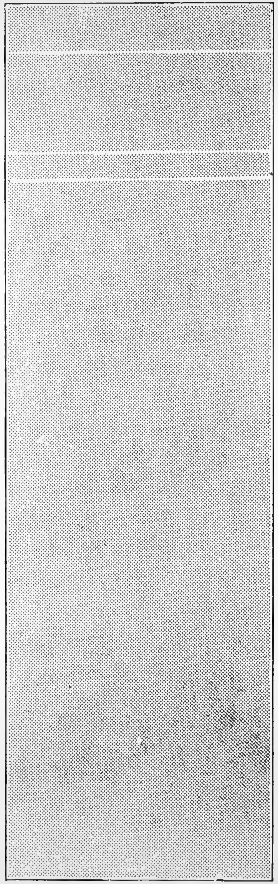

PLATE 24.
100 pounds low grade flour—exact volume, 12x12x30.73 inches.

Water,
11.1 pounds.

Indigestible material,
11.6 pounds.

Ash, 2.5 pounds.

Protein,
14.8 pounds.

Carbohydrates,
56.5 pounds.

Fat, 3.5 pounds.

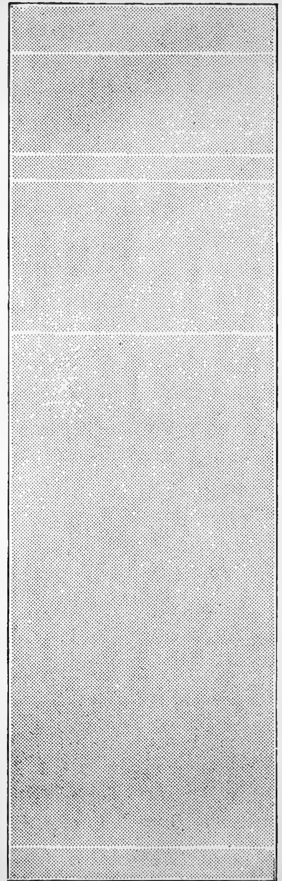

PLATE 25.
100 pounds low grade flour—exact volume, 12x12x30.73 inches.

For these reasons the feeder is interested in low-grade flour only to the extent that if it becomes possible at any time for him to purchase feeding nutrients in that form at a price more reasonable than in any other form, he may be in position to do so and feed it according to the methods by which its use can be successfully and profitably employed.

Plate No. 23 illustrates the comparative bulk of it as a dairy feed, and the low proportion of moisture to the dry matter.

Plate No. 24 shows its value as compared with shorts, middlings and bran.

Low-grade flour contains a much lower percentage of indigestible material than these by-products and lacks only 4 per cent of containing as large an amount of digestible material per 100 pounds as ground wheat. From the standpoint of ash content it is considerably more valuable than ground wheat, containing nearly 50 per cent more of this essential material.

Considered from the standpoint of digestible protein and fat content, low-grade flour is much superior to ground wheat, as indicated by plate No. 25.

It may be stated that low-grade flour fed in such amounts as are agreeable to the likes of the cow is somewhat more valuable than middlings or bran in supplying digestible feeding nutrients and furnishes more ash and protein than either ground corn or ground wheat and more fat than the latter, although it is less valuable than either in supplying digestible carbohydrates.

Wheat Middlings or Shorts

Strictly speaking these two by-products are dissimilar. Very often one product is sold under both names. The purchaser should insist on securing wheat middlings, regardless of whether it is sold under that name or under the name of shorts. Technically, shorts, consisting of reground bran and mill sweepings, vary greatly in value and feeding analysis. If purchased at all by the discriminating dairyman, they should be purchased at a price sufficiently low to justify their use.

On the other hand, wheat middlings are valuable, being well proportioned in digestible nutrients and containing one pound of protein to 4.1 pounds of digestible carbohydrates and carbohydrate equivalents.

As shown by plate No. 26, middlings are much more bulky than either ground wheat or low-grade flour and contain a large amount of dry matter in proportion to moisture.

Plate No. 27 illustrates one very valuable factor incorporated in wheat middlings, as well as the factor which shows why wheat

middlings should not be considered worth as much per ton as are many other feeds.

Wheat middlings are especially valuable in furnishing mineral matter, containing as they do 4.4 pounds of ash per 100 pounds. As in wheat, this mineral matter is valuable because it is largely composed of phosphorus and potash, the essential ingredients for bone development as well as for stimulating milk and butterfat production. Added to a ration lacking in these minerals wheat middlings are, indeed, valuable.

It is also shown in this illustration that middlings contain 21.3 pounds of indigestible material in each hundredweight. Because of this, in each ton there are present 426 pounds of material which is of no value except as it gives bulk to the ration and thereby aids in the digestion of other foods. Because, however, a ton of middlings contains only 1,574 pounds of digestible nutrients, including water and ash, or only 1,366 pounds of digestible nutrients, exclusive of water, the practical feeder will at once recognize that if he pays a high price per ton for middlings in comparison with many other feeds, he cannot expect his results will be economical even though they may be large.

A comparison of plate No. 28 with plate No. 25 shows wheat middlings to contain .8 per cent more fat than low-grade flour, but 10.3 per cent less digestible carbohydrates and 1.4 per cent less digestible protein.

Like low-grade flour, but to a lesser extent, wheat middlings become sticky and pasty when mixed with saliva, and, therefore, their use should be employed with other feeds that will counteract this disadvantage.

Where wheat middlings can be purchased at a price as low as ground corn or ground wheat, they may be advisably used as a substitute for a portion of these other feeds. Where higher in price they should be used merely to furnish bulk, protein and mineral matter.

Bran

Bran is one of the very best feeds for dairy cattle. It combines many virtues for which it is difficult to substitute other feeds, although when the price of this by-product exceeds its real value successful substitution is possible.

Bran is bulky. Being composed of the outer layers, or covering, of the wheat kernel, bran of acceptable quality is light and flaky, and, when added to the ration in liberal amounts, renders the ration more readily digestible than though a heavier weed were used. The greatness of this bulk as compared with other concentrated foodstuffs is made apparent by plate No. 29.

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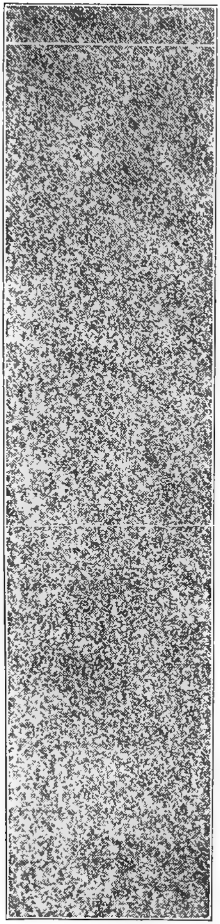

PLATE 26.
100 pounds wheat middlings —exact volume, 12x12x41 inches.

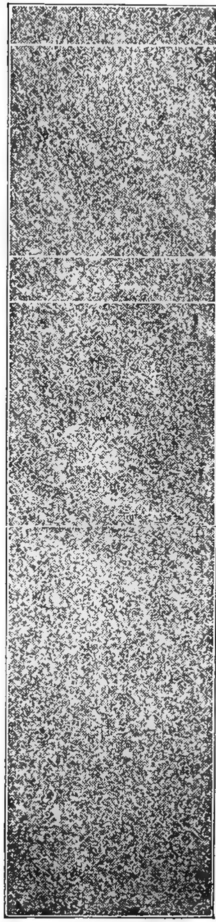

PLATE 27.
100 pounds wheat middlings —exact volume, 12x12x41 inches.

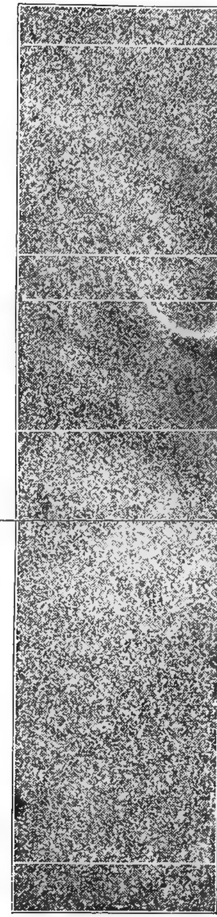

PLATE 28.
100 pounds wheat middlings —exact volume, 12x12x41 inches.

Bran is extremely palatable to the dairy animal and eaten with avidity. Because of this palatability and its light, bulky nature, it has a cooling effect upon the digestive system. Where rations are composed largely of bran, cows are not so liable to sicken or go "off feed" as when rations are compounded without its use.

Bran has a laxative effect upon the digestive system of the animal, which action, until recently, was presumed to be due to its physical character. More recently experiments conducted at the New York Experiment Station seemed to demonstrate that the large amount of phosphorus present in the mineral matter of bran not only accounts for the laxative effect but also for the fact that the condition of the animal is so well preserved when bran is liberally fed.

This determination was by a system of experiments where whole bran was fed in comparison with washed bran or bran from which the mineral matter had been leached by washing with water. It was found quite definitely that bran from which the mineral matter had been extracted encouraged a larger milk flow, but that whole bran encouraged a higher percentage of butterfat and a more laxative condition of the digestive apparatus.

Plate No. 30 is of interest and value in that it shows the presence of 6.3 pounds of ash per hundredweight of bran. This is a much larger percentage of mineral matter than is contained in any feed heretofore considered in this discussion. This illustration also points to the deficiency of bran, which is its content of indigestible material, amounting to 26.5 per cent. This, added to the 10.1 pounds of water contained in each hundredweight of bran, points to the extravagance of paying the large prices that are now current for this by-product. In each ton of bran the purchaser secures 732 pounds of water and indigestible material and only 1,268 pounds of digestible nutrients which go to produce milk and butterfat.

So well recognized, however, is the fact that bran is a useful and valuable food for dairy cattle, feeders have permitted themselves to disregard the fact that equal value can be supplied by the use of cheaper feed. On many dairy farms extensive use of wheat bran largely decreases the profit from milk and butterfat production.

At present prices there is no justification in purchasing bran from the standpoint of furnishing protein, carbohydrates or fat. This fact is illustrated definitely by plate No. 31, which shows the low content of each of these nutrients as compared with other foods that can be purchased at a trifle higher price per ton. Because of this the wise feeder will secure the necessary digestible nutrients from other sources, and, if he finds it necessary to use wheat bran

at all, will use it in a limited manner merely to add bulk, palatability and phosphorus to the ration.

At certain seasons of the year wheat bran is comparatively cheap in price and if the feeder is thoughtful he will estimate closely the amount necessary for his feeding operation, covering an entire year, and lay in his supply at that time. Unless he does so, he can rest assured that he can secure much more economical results by employing other feeds and using very lightly of bran.

There are conditions which often exist on dairy farms when the use of wheat bran is essential and when no other feed can be successfully substituted. These conditions exist at parturition time and when animals are out of condition. Even though bran commanded a higher price per ton than it does at the present time, its use could well be employed for preparing animals for freshening or for conditioning the over-worked digestive apparatus.

All dairy cows should be taught to eat bran mashes with avidity. When the cow approaches within two weeks of freshening, her concentrated ration should consist of a liberal supply of bran mixed with ground oats and linseed meal worked into the form of a mash with water. At this period the cow will learn, with a day or two of teaching, to eat such mashes, and as parturition approaches she will round into perfect condition to give birth to her offspring and start on her new lactation period. Three or four days following freshening she may be returned to solid feed and, if the price of bran indicates the necessity, this by-product may gradually be eliminated from the ration, either in whole or in part, and other foods substituted.

Now that the cow has become accustomed to mashes and relishes them, at any time during her milking period when she tires of solid feed and begins to decline in milk flow, she may have her digestive apparatus rested by substituting bran mashes for a short time in place of the more solid food to which she has been subjected.

So valuable is bran in any ration, it can well be used when the price is within reach. Always it can and should be used for special purposes. The feeder should bear these two facts in mind and use bran liberally when its worth justifies its price, and to an extent price should be overlooked when its use is employed for special purposes.

When bran was extremely cheap, advisors became so accustomed to recommending its use that it seems difficult for them to overcome the habit. Even today dairy farmers in all parts of the world are advised to use wheat bran largely; and this in the face of the fact that in most sections it has reached a price where the feeder

stuffs, at

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cordance

Water, 10.1 pounds.

Dry matter, 89.9 pounds.

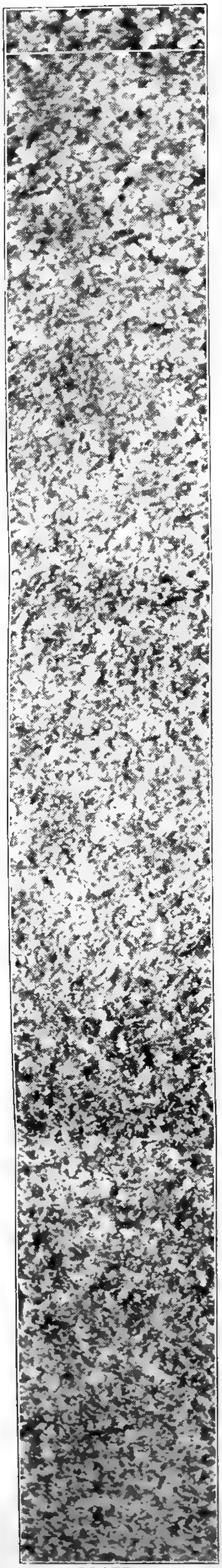


PLATE 29.
100 pounds wheat bran—exact volume, 12x12x73¾ inches.

Water, 10.1 pounds.

Indigestible material, 26.5 pounds

Ash, 6.3 pounds.

Digestible material, 57.1 pounds.

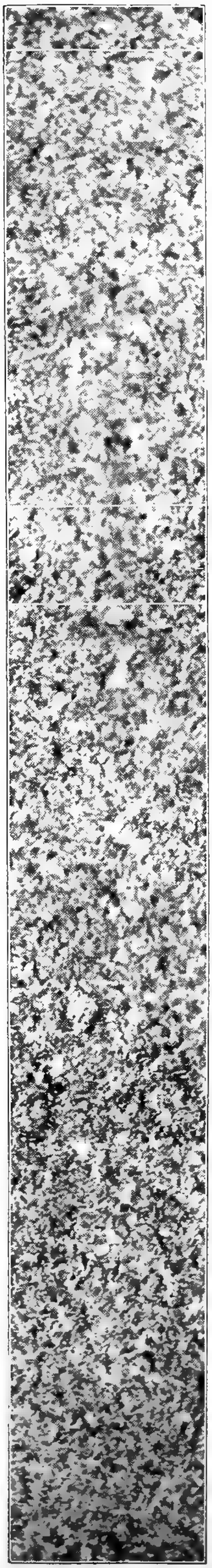


PLATE 30.
100 pounds wheat bran—exact volume, 12x12x73¾ inches.

Water, 10.1 pounds.

Indigestible material, 26.5 pounds.

Ash, 6.3 pounds.

Protein, 12.5 pounds.

Carbohydrates, 41.6 pounds.

Fat, 3 pounds.

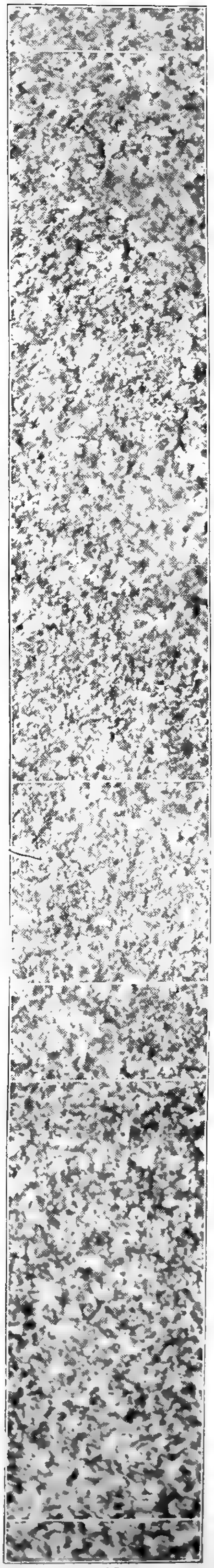


PLATE 31.
100 pounds wheat bran—exact volume, 12x12x73¾ inches.

can secure all of the values bran possesses from other foodstuffs, at a cheaper price, by properly mixing them.

As surely as dairying is carried on for the profit which accrues from it, the dairyman should use bran judiciously, in accordance with its necessity and its worth compared with its cost.

CHAPTER V.

OATS

As a single concentrated feed for all classes of dairy animals oats have no superior. When ground, crushed or rolled they are palatable, bulky, light, easily digested, and when fed in abundance with leguminous hays and silage they furnish digestible feeding nutrients in just about the proper proportion. In fact, oats illustrate as nearly as one single grain can what a concentrated dairy ration should be. Practical feeders have long recognized this fact, and even those who doubt the value of a balanced ration, when referred to as such, discover in oats—which by themselves form a balanced ration—a feed most suitable for growing young animals, feeding work horses and stimulating large milk production.

Trainers of race horses have been the most persistent champions of oats. It is generally believed among horsemen that a peculiar characteristic possessed by oats, and not by any other grain, is that of imparting stamina and vim to the animal fed largely of them. Even chemists have in the past believed they have discovered the presence of alkaloid and to this they have attributed the value peculiar to oats. Whether this is the solution of why this grain meets with so general favor with the practical feeder is not definitely known.

There are several well defined reasons why oats, especially when properly combined with other feeds, should prove very satisfactory in formulating rations.

They are extremely palatable. Only one cow have I ever known that would not with avidity and in abundance eat ground oats. They are bulky, as illustrated by plate No. 32, and, therefore, they are not only readily digested but, because of the beneficial effect they have on the digestion of other concentrates with which they are mixed, they aid in the digestion of the entire ration. Because of their light, bulky, palatable character, animals eat largely of them with more safety than though they were more concentrated and less readily digested.

Plate No. 33 indicates—as is the case with bran—that oats contain an appreciable amount of indigestible material. This fact is due to the presence of the hull, which is largely crude fibre and of little feeding value other than adding bulk. On account of this, and because ground oats cost so much they are considered too expensive where economical, as well as large, results are the aim. For special purposes it is permissible to feed them. Under most conditions the

Water,
10.8 pounds.

Dry matter,
89.2 pounds.

PLATE 32.
100 pounds ground oats—exact volume, 12x12x56.5 inches.

Water,
10.8 pounds.

Indigestible material,
21 pounds.

Ash, 3.3 pounds.

Digestible material,
64.9 pounds.

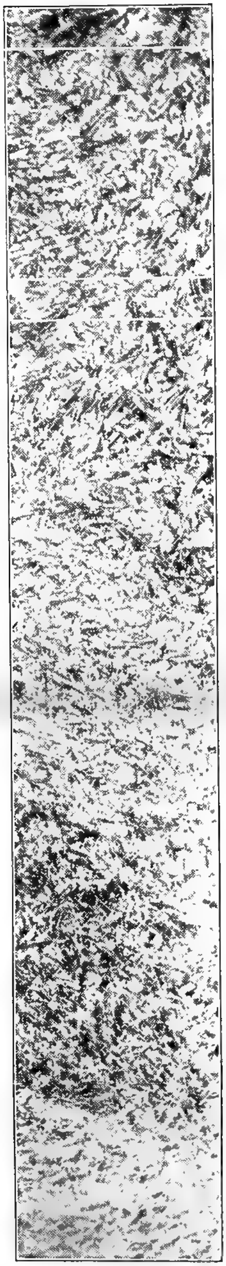


PLATE 33.
100 pounds ground oats—exact volume, 12x12x56.5 inches.

Water,
10.8 pounds.

Indigestible material,
21 pounds.

Ash, 3.3 pounds.

Protein,
9.4 pounds.

Carbohydrates,
51.4 pounds.

Fat, 4.1 pounds.

PLATE 34.
100 pounds ground oats—exact volume, 12x12x56.5 inches.

wise feeder will arrange his rations in a manner necessitating the smallest possible use of oats in order to enlarge his profits.

Experiment has shown ground oats to be at least 10 per cent more valuable for stimulating milk production than is bran. Therefore, in choosing between bran and oats the feeder can by bearing this comparison in mind determine for himself when it is economical to use oats for general feeding purposes. For instance, when bran costs $25 per ton, ground oats costing $27.50 per ton are economical to feed in substitution for bran or in conjunction with it.

Mineral matter to the extent of 3.3 pounds is found in 100 pounds of oats. This and the 64.9 pounds of digestible dry matter constitute the real feeding value of a hundredweight of oats. This is not a large amount as compared with other foods such as ground corn, gluten meal, cottonseed meal, oil meal, etc.

The distribution of digestible nutrients in ground oats is shown in plate No. 34. Although oats are not high in protein they are not high in carbohydrates and fat either. Therefore, the proportion of protein to carbohydrates and carbohydrate equivalents is as one pound is to six pounds. It is this proportion of nutrients that renders ground oats well balanced as a sole ration.

Under certain conditions cost of digestible nutrients is a consideration of secondary importance. For this reason there are times when oats can be used though they seem expensive.

No feed is more useful for conditioning cows to freshen and for starting them on their yearly lactation period than ground oats. Every hard-working cow should be turned dry and given six weeks rest between lactation periods. As soon as completely dry, systematic and liberal feeding should be commenced. Ground oats are excellent for the purpose, and cows may be fed from 8 to 12 pounds without danger to their health. Such feeding adds flesh, strength and stamina to the cow's body and brings her through the parturition period in a most excellent condition. She gives birth successfully to a strong, rugged calf and starts her year's work in a most commendable manner without being overfed at this time when naturally she is weakened from the effects of parturition. More than this, she milks with persistence because she is able to reserve for a long time the surplus flesh and stamina she has been encouraged to store in her body. Expensive, therefore, as oats may be and even though too expensive to feed under ordinary conditions, they are one of the most economical feeds for use during a period covering 30 days prior to freshening, when the purpose for which feed is given is to establish certain conditions, and for 30 days following freshening, when the purpose is that of encouraging regular and large daily increase of milk yield. At

no other time is it so important to use excellent methods in feeding dairy cows as during the 60-day period just referred to. The manner in which a cow is brought through this part of her year governs very largely the amount of milk and butterfat she will yield during her lactation period.

For young and growing animals it is well known that oats are excellent. It is difficult, indeed, to provide a ration for young, growing calves without the use of oats. Up to the time a calf reaches the age of one year it is permissible and advisable to feed whole oats. This is because one of the points to be observed in feeding calves is to develop and distend the digestive apparatus. A characteristic of the young calf's feeding power is that whole oats are thoroughly and readily digested. After the calf has passed the age of one year, however, changes take place in the digestive apparatus, and no longer can whole oats be fed with economy because a large percentage of them pass on undigested and are wasted.

Expensive as oats are for feeding purposes when ground, they may be considered from 10 to 25 per cent more expensive when fed whole. Experiments show that when fed alone, or with other concentrates, from 10 to 25 per cent are wasted because undigested. With the exception of when oats are fed to young calves, they should be thoroughly ground in order to accomplish the purpose for which they are given and to make their use other than prohibitive because of cost.

It is true that one distinct advantage with regard to oats is that they are in most sections, home grown. Nevertheless, they have a distinct market value, so that with the exception of using them for special purposes their use should be determined on a business basis and with regard to furnishing the ration with palatability, bulk, mineral matter and digestibile nutrients in the most efficient and economical manner.

At elevators where they are screened there is an offal consisting of the very lightest kernels, and these are valuable in accordance with the proportion of the kernel to hull, which is not usually very large. If these light oats are to be used at all, they should be secured at a very low price. In oatmeal factories the oat hulls, the light oats and oat dust are made available as by-products, but these are utilized very largely by commercial feed manufacturers and not generally available. Even though they were, their value would be large or small according to the manner in which they were mixed with other foods. They are useful very largely for giving bulk and palatability to other feeds with which they are mixed, and apparently the stimulating properties of oats are contained in these by-product materials.

Oat Meal or Rolled Oats

It sometimes occurs, though seldom, that the feeder finds oat meal, that for some reason or other is not suitable for human food, available for feeding purposes. Perhaps it has become a trifle moldy, old or dry and is unsalable. In such instances it can be purchased as cheaply as or sometimes more cheaply than ground oats. When this opportunity presents itself the wise feeder will certainly purchase it in preference to any other oat product. Experience teaches that where price makes it possible to use oat meal, it is one of the very best of foods for stimulating milk production.

Seemingly it has all the value of ground oats with the disadvantage, occasioned by a large percentage of the indigestible material, removed. It is a much heavier product and not so bulky, as is illustrated by plate No. 35. It is very palatable and easily digested. Cows can eat largely of oat meal or rolled oats without any ill effects. There is no better food for conditioning cows for freshening; neither is there a better food for stimulating rapid increase in milk production after freshening, without overfeeding, than rolled oats.

There are expert and experienced feeders striving for large records with the economy of production a secondary consideration who use rolled oats during the first 30 days of a cow's lactation period with much success. Because of the expense, however, they are used sparingly and more largely as an appetizer and a stimulator than as a real source of feeding nutrients.

That rolled oats are more valuable to a considerable extent than are ground oats is made apparent by comparing plate No. 36 with plate No. 33. In 100 pounds of rolled oats there are 2.9 pounds of water, 6.6 pounds of indigestible matter and 1.3 pounds of mineral matter less than in a like amount of ground oats.

Because of this, there are 10.8 pounds more digestible material. In other words, there is considerably more feeding value in rolled oats than there is in a like amount of ground oats. Therefore, it is only reasonable to conclude that rolled oats are worth approximately 17 per cent more for feeding purposes, so that, when ground oats are selling for $36 per ton, $42 per ton for rolled oats would not be more expensive, and their use at this price could be employed for special purposes, provided the feeder was justified in using ground oats at so high a price as $36 per ton.

The only criticism offered in the use of either ground or rolled oats is that they are so expensive nowadays that by-products can be substituted for them, rendering feeding operations more economical and securing equally as good results.

PLATE 35.
100 pounds oat meal—exact volume, 12x12x33.5 inches.

PLATE 36.
100 pounds oat meal—exact volume, 12x12x33.5 inches.

PLATE 37.
100 pounds oat meal—exact volume, 12x12x33.5 inches.

Schumacher Feed

In the process of manufacturing rolled oats, the by-products are light oats, oat hulls, oat clippings, oat middlings, and oat shorts. There seems to be a general belief that these by-products in themselves are very lacking in feeding value. To a large extent this is true, but the manufacturers of oat meal, like other manufacturers, realize that, in order to pay the largest possible price for oats and at the same time sell the resulting oat meal product as cheaply as possible, so it will be a ruling factor in competitive commercial channels, they must make the best possible use of their by-products. Therefore, these undesirable parts eliminated from the oat meal are mixed with such other ingredients as will insure feeding value. They are then thoroughly mixed and ground. The resulting product is Schumacher feed.

This feed, although finely ground, is quite bulky; in fact, 100 pounds of it occupies the same space as a like amount of rolled oats. The water content, as indicated by plate No. 38, is practically the same as that of ground oats, so it also contains a like amount of dry matter. A comparison of plates Nos. 33 and 34 with plates Nos. 39 and 40 will be of much interest, for they reveal the fact that Schumacher feed and ground oats are largely the same with regard to the digestible nutrients, the ash and the indigestible material contained in them. The largest difference between these two feeds is that ground oats are much more bulky and perhaps a trifle more palatable.

Experienced feeders of dairy cattle through practical trials have learned, however, that Schumacher feed is almost, if not quite, as valuable for feeding dairy cows as are ground oats. Because of the high price of oats, Schumacher feed is quite generally used on farms where thoughtful feeders are striving for large and economical results.

The Massachusetts Agricultural Experiment Station experimented with Schumacher feed to determine its feeding value and its digestibility of nutrients. (See plates Nos. 38, 39 and 40.) The Massachusetts station says: "The digestibility, as well as the composition, of this feed resembles that of oats."

Because Schumacher feed resembles oats so closely, there would be no justification for a farmer using it in preference to ground oats; in fact, we would be inclined to advise the use of ground oats instead, because they are a home-raised product, while Schumacher feed is a commercial product and must be purchased off the farm; but there is a controlling factor which prohibits our recommending the use of ground oats and also encourages us to use Schumacher feed. This

Water,
10.5 pounds.

Dry matter,
89.5 pounds.

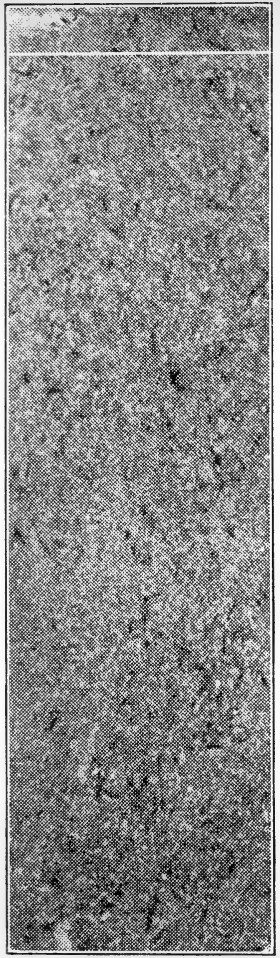


PLATE 38.
100 pounds Schumacher feed—exact volume, 12x12x33.5 inches.

Water,
10.5 pounds.

Indigestible material,
21.27 pounds.

Ash, 3 pounds.

Digestible material,
65.23 pounds.

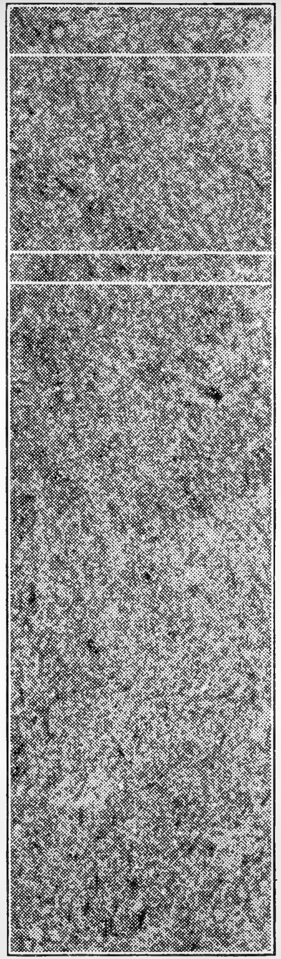


PLATE 39.
100 pounds Schumacher feed—exact volume, 12x12x33.5 inches.

Water,
10.5 pounds.

Indigestible material,
21.27 pounds.

Ash, 3 pounds.

Protein,
7.67 pounds.

Carbohydrates
54.47 pounds.

Fat, 3.09 pounds.

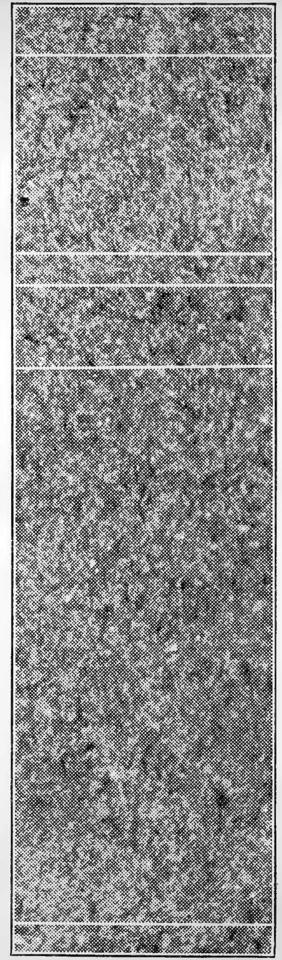


PLATE 40.
100 pounds Schumacher feed—exact volume, 12x12x33.5 inches.

factor is the difference in the cost. Rather recently it has been possible to purchase Schumacher feed for approximately $10 less per ton than ground oats. In substituting this by-product for ground oats, when it is gradually done, the feeder will find that cows will yield quite as large an amount of milk and butterfat and at considerably less expense.

So long as the present variation in price between these two useful foods continues to exist, the farmer who raises oats will be justified in marketing them, instead of having them ground, and purchasing Schumacher feed in their place to feed with the other feeds in use. In so doing, a very perceptible saving will be made, resulting in a more economical production of milk and butterfat.

CHAPTER VI.

FLAX AND ITS BY-PRODUCTS

The average annual production of flaxseed in the United States from 1909 to 1913 was 20,000,000 bushels. In 1914, 16,000,000 bushels were harvested and a like amount is estimated as the yield of 1915. In 1909, according to the report of the United States Department of Agriculture, 25,767,000 bushels were harvested. These figures show the rapidity with which the growing of flaxseed in the United States has decreased. It is generally believed that the growing of flax should be limited to new land.

In addition to the flaxseed grown in this country, millions of bushels are imported. Primarily, its value is based upon the linseed oil which can be extracted from it. Linseed meal, or oil meal, is merely a by-product of the linseed oil factory.

Flaxseed meal, or ground flaxseed, would be very valuable to feed in small amounts to dairy cattle were it not for the fact that its cost prohibits its use for this purpose. It is especially valuable for feeding with skim-milk to calves because of its digestibility and its high content of fat. So saturated with linseed oil is ground flaxseed that the chemical analysis shows 29 per cent of digestible fat as compared with only 17.1 per cent of carbohydrates and 20.6 per cent of protein. Owing to the fact, however, that carbohydrates serve the same purpose as fat in foodstuffs, it is doubtful if ground flaxseed can economically be fed to any large degree even to calves. In special instances its use may be advised to a limited degree.

Raw linseed oil extracted from ground flaxseed has great value in the dairy. This is especially true where cows are being fed for large production. Very often cows fed heavily sicken of their feed and are troubled with indigestion. Unless given immediate aid at such times serious results follow and the cow refuses to produce profitably during the remainder of her lactation period.

The feeder who closely watches his cows will detect the first symptoms of an animal "going off feed." He will then decrease perceptibly the amount of feed given, and, if the trouble seems severe, he will take the entire ration away from the animal for one or two feeds. In place of her regular ration, he will find that a quart of raw linseed oil, given as a drench in a careful manner so as not to choke the cow, will not only adjust the digestive activities of the cow but will furnish nutriment in sufficient abundance to maintain her milk flow and butterfat production.

During the St. Louis World's Fair cow demonstration, when the cows under the writer's supervision were feeding close to the limit of capacity day after day, it was necessary to keep the digestive apparatus of every cow in as nearly perfect working order as possible. As a matter of fact, the digestive system of the cow is the hardest-worked portion of her body. So long as it is kept in healthy working order, the cow can be induced to do her very best in the yield of milk and butterfat. To insure this, raw linseed meal—in five-gallon lots—was kept available at all times. Upon the first indication of a cow weakening in digestive capacity her regular grain ration was withheld and for it a quart of raw linseed oil was given. When the following feeding time arrived, if the cow gave evidence that her condition was again normal and her appetite was customarily voracious, her regular ration, decreased a pound or two, was given her. Otherwise, another quart of raw linseed oil was given her instead. With such treatment, begun in time, I have seldom seen a case of indigestion so severe that the substitution of two quarts of raw linseed oil for two regular feeds of concentrates would not restore a normal digestion. Raw linseed oil is more advisable than a radical physic, if the case is taken in time, because it is not only a cooling, soothing bowel corrective, but furnishes nutriment to the extent that the cow is encouraged to continue to milk quite as largely as though her regular concentrated ration were being fed.

Those who use linseed oil for this purpose, however, should be very insistent when purchasing it that raw linseed oil is furnished; because boiled linseed oil, which is so largely used in mixing paint, is poisonous when administered internally to animals.

Of greatest importance to the dairymen is linseed meal. There are two types of this by-product known as old process linseed meal and new process linseed meal. The old process results when the oil is pressed from the seed by hydraulic pressure. When the oil is extracted by treating flaxseed with the chemical naphtha, the resulting residue is steamed, dried and ground, and known as new process oil meal. Most of the oil meal manufactured in this country is by the

			Digestible Nutrients		
	Water	Ash	Protein	Carbo-hydrates	Fat
Oil meal—					
Old process	9.1	5.4	30.2	32.6	6.7
New process	9.7	5.5	31.7	37.9	2.8

Water, 9.1 pounds.

Dry matter, 90.9 pounds.

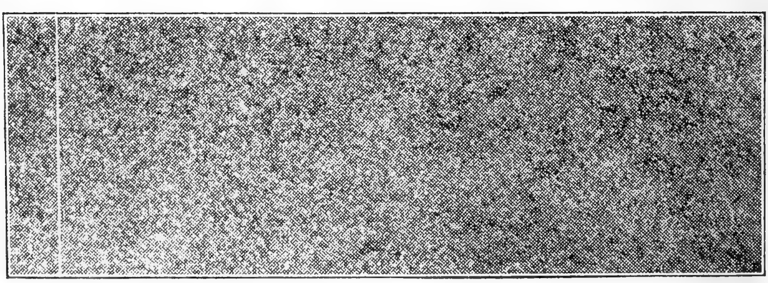


PLATE 41.
100 pounds linseed meal (old process)—exact volume, 12x12x26.35 inches.

Water, 9.1 pounds.

Indigestible material, 16 pounds.

Ash, 5.4 pounds.

Digestible material, 69.5 pounds.

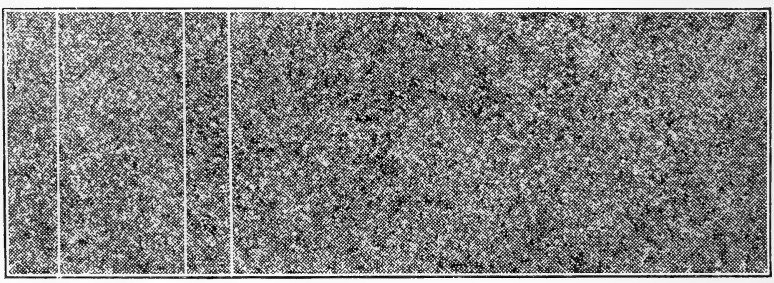


PLATE 42.
100 pounds linseed meal (old process)—exact volume, 12x12x26.35 inches.

Water, 9.1 pounds.

Indigestible material, 16 pounds.

Ash, 5.4 pounds.

Protein, 30.2 pounds.

Carbohydrates, 32.6 pounds.

Fat, 6.7 pounds.

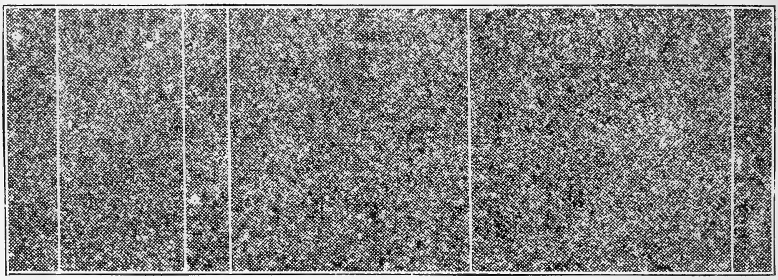


PLATE 43.
100 pounds linseed meal (old process)—exact volume, 12x12x26.35 inches.

old process. This is fortunate because it is superior, all things considered, in feeding value as a comparison of the analyses implies.

New process oil meal has a larger content of protein and carbohydrates but old process oil meal excels in fat.

Primarily, linseed meal is used because of its high content of protein, and, from this standpoint, the new process meal would be superior by 1.3 per cent of this nutrient. However, it is not to be denied that protein can be secured more cheaply from other available foodstuffs than it can from linseed meal, and, were this the only consideration, there would be little justification in its use. Oil meal has a secondary value, which, in conjunction with its high content of protein, renders its use advisable on every dairy farm for certain purposes. It possesses a physical value not possessed by other feeds, and this value apparently increases in proportion to the amount of oil or fat present. Because of this, old process meal, which is practically as valuable as the new process for furnishing digestible protein, is superior.

Especially when animals are on dry feed, old process oil meal is serviceable in keeping the digestive apparatus in healthful, working condition, and, used in amounts varying from one to two pounds daily, greatly aids the digestion of other foods.

The only objection to linseed meal is that it is expensive for furnishing nutriment. Its cost is governed largely by supply and demand. Feeders in foreign countries are very partial to oil cake, and large tonnages of it are exported from the American mills.

The cake differs from the meal in that it is unground. It is preferred to the meal by foreign feeders because it is less expensive and there can be adulteration. The foreign feeder believes that an excellent opportunity is offered for mixing adulterants with the linseed when it is ground and sacked. The American feeder can well afford to consider purchasing linseed in cake form, rather than meal, for the same reasons, and especially because it can be bought for at least $5 per ton less than where it must be ground and sacked.

Furthermore, when stored in cake form and broken or ground just before feeding, the rich, nutty flavor which adds to palatability is retained.

Linseed meal or cake is especially valuable to use in fitting animals for sale or show purposes. Shortly after its use is adopted, the feeder perceives that the hide of the animal softens, the hair becomes more silky and the animal takes on a more lively, active, energetic appearance. These are merely indications of an active, thrifty, efficient digestion, for it is well known that the hide and hair are merely continuations of the inner, vital organs of the animal. The condition of

the digestive apparatus is readily reflected in the hide and hair of the animal. Therefore, any food that acts favorably upon the healthfulness of the digestive apparatus indicates itself in outward appearances and handling quality.

In preparing cows for freshening, oil meal is exceptionally valuable, and, fed with ground corn, ground oats and bran at the rate of two pounds daily for 60 or 90 days prior to freshening, it develops a condition of quality and snappiness in the cow that insures successful parturition and promptness in coming to her maximum flow of milk.

From the standpoint of supplying protein and mineral matter, linseed meal is valuable. For these purposes alone, however, the great demand from Europe makes it possible for the American farmer to supply rations with these requirements more economically from other feeds. From the standpoint of accomplishing such purposes as already referred to and for keeping the animal in a healthful, thrifty, vigorous condition, there is no feed that can entirely take the place of linseed. Considering these facts, the careful feeder who demands uniformly large results will always keep on hand enough linseed meal, or linseed cake, so it can be used in limited amounts as occasion and necessity demand.

In sections where it is necessary to purchase commercial fertilizers and in sections where fertility of the land should be conserved —and this means every section of the world—there is a third distinctive value which oil meal, like all other such feeds, possesses. Valuing nitrogen at 20c per pound, phosphoric acid and potash each at 5c per pound for fertilizing purposes, it is to be found that one ton of old process linseed meal contains $24.71 worth of these fertilizing ingredients. When fed to livestock a large percentage of this value remains in the excrement and can be transferred to the fields if the barnyard manure is properly cared for. The fact that such commercial foods carry so much fertilizing value has not in the past been considered seriously enough by the American farmer. It is for this reason, that to a very large extent, the fertility of American farms has been and is being transferred across the ocean to enrich European lands, and this is one reason why, even though European farms have been cultivated so much longer than have American farms, the average production per acre is greater.

CHAPTER VII.

RYE AND RYE SHORTS

Rye and its by-products are not largely used, neither are they considered, to any great extent, in compiling dairy rations.

Rye and rye shorts, as shown by the accompanying plates, are carbonaceous in character, concentrated in form, and, according to analysis, should prove valuable as dairy feeds. Both are palatable to the animal, and both, especially rye shorts which is a by-product in the milling of rye flour, are cheap in price per ton. Digestible feeding nutrients, both protein and carbohydrates, can often be purchased very cheaply as in rye and rye products compared with other foods containing as large an amount of food value.

There are three great objections to rye and rye shorts as dairy foods, however, and these reasons undoubtedly account for the fact that rye and its by-products, where fed at all to livestock, are used almost exclusively for hog feeding purposes.

Rye imparts to milk, produced by its use, a characteristic, disagreeable flavor, and when butter is made a bitter taste is present. Were this the only objection, it could be overcome readily by limiting the use of rye to three or four pounds daily and by feeding this immediately after milking. In sections where rye shorts and rye bran can be secured at a price sufficiently low to justify their use, the dairyman, after assuring himself that there is no ergot on it, can well afford to utilize these by-products to a limited degree and in a judicious manner.

Undoubtedly the most serious objection to rye, rye shorts and other by-products is the likelihood of ergot being present. It is a well known fact that ergot causes abortion, and, in many instances where indications have led to the belief that contagious abortion had attacked the herd, investigation proved that ergot, secured by the cows from such a source as rye, wild rye, rye straw or from certain wild grasses, had caused the trouble. In addition to causing abortion, ergot also poisons cattle, causing symptoms much like those of paralysis. The animal becomes lame in the hind quarters, her legs swell, later she loses much of her hair and very often the bush of the tail is lost. In severe cases animals lose their hoofs and die.

Ergot is not always present in rye and the occurrence of abortion and poisoning is not the rule. For this reason, it is usually considered safe to feed rye in small amounts. Those accustomed to

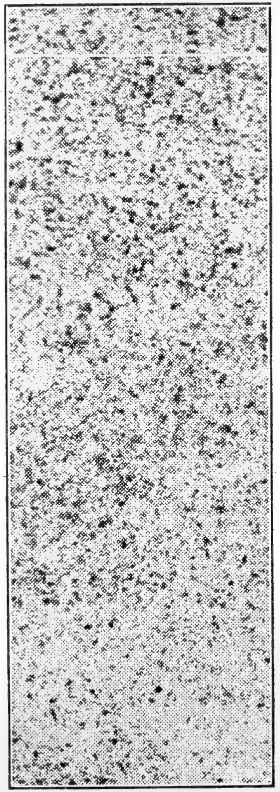


PLATE 44.
100 pounds ground rye—exact volume, 12x12x27.3 inches.

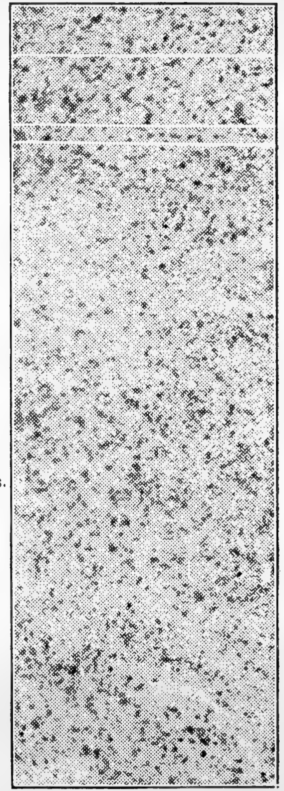


PLATE 45.
100 pounds ground rye—exact volume, 12x12x27.3 inches.

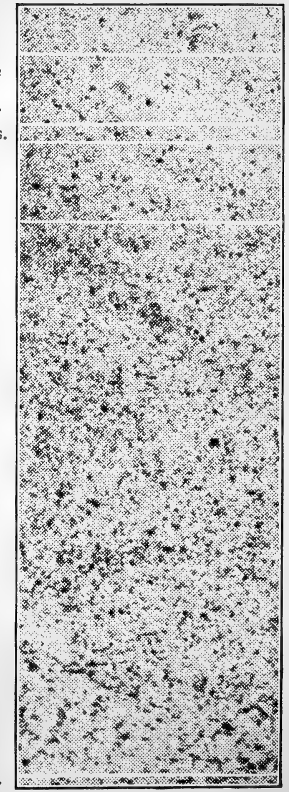


PLATE 46.
100 pounds ground rye—exact volume, 12x12x27.3 inches.

feeding it soon learn to detect the appearance of ergot and thereby eliminate the difficulty that would be experienced by one not familiar with this fungus growth which is occasionally present and creates havoc.

Rye is more largely used as a green feed, or soiling crop, and for this purpose it is especially valuable. Sown in the fall, it furnishes green feed later in northern climates than most any other grass or cereal. When spring opens, the rye field is the first to become green, and it furnishes green food earlier than any other pasture grasses or soiling crops. Fed green, rye is very palatable and stimulating to milk production. It is perfectly safe to use as a late green feed for fall and an early green feed for spring, but, as it approaches maturity, the feeder should make certain that it carries no ergot if he would continue its use as a feed instead of plowing it under as a green manure or removing the cattle and letting the rye mature as a cereal crop.

As a rule, rye commands a good price on the market. Where, as is usually the case, it is possible to secure other foods for dairy purposes, the advisable plan is to dispose of the rye and secure other foods, the use of which is safer and the feeding value of which is greater.

Rye is largely used for distilling purposes, and dried distillery grains are considered among the most valuable of dairy feeds. In a later chapter, however, it will be shown that when they result from the use of rye they are the least valuable of the various kinds of distillery grains manufactured.

Rye is often referred to as "the crop of poverty" or "the poor man's crop," and it is a well known fact that it will grow and thrive on land where other crops won't. It might also be referred to as the poor cow's crop, for a careful study of its value as dairy feed shows conclusively that, other than in the green state, it does not especially encourage large production.

Rye is the least advisable grain that can be grown for dairy purposes except that it is very hardy and can be grown in many sections with more certainty than can other grains. This, together with the fact that rye shorts can oftentimes be purchased cheaply, furnishing protein and carbohydrates in a digestible, palatable form at small cost, is the only reason why rye and its by-products should be considered at all for feeding dairy cattle.

Water,
11.5 pounds.

Dry matter,
88.5 pounds.

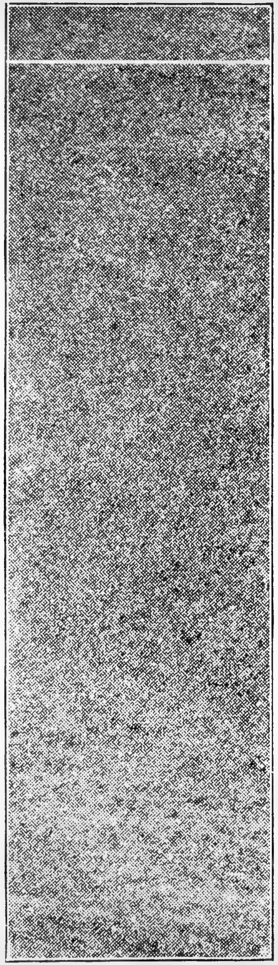


PLATE 47.
100 pounds Rye Shorts—exact volume, 12x12x33.5 inches.

Water,
11.5 pounds.

Indigestible material,
13.8 pounds.

Ash, 3.8 pounds.

Digestible material,
70.9 pounds.

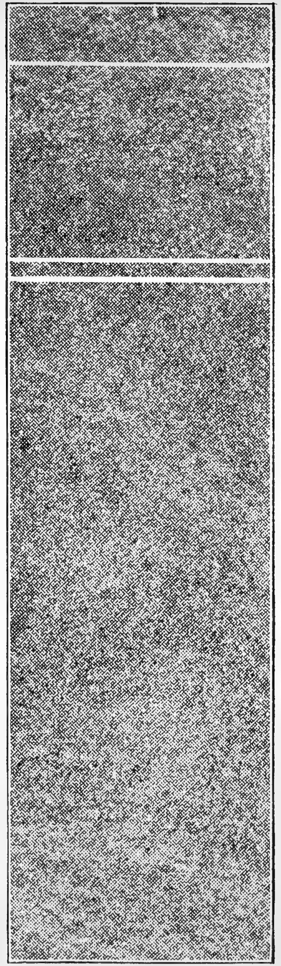


PLATE 48.
100 pounds Rye Shorts—exact volume, 12x12x33.5 inches.

Water,
11.5 pounds.

Indigestible material,
13.8 pounds.

Ash, 3.8 pounds.

Protein,
12.2 pounds.

Carbohydrates,
55.8 pounds.

Fat, 2.9 pounds.

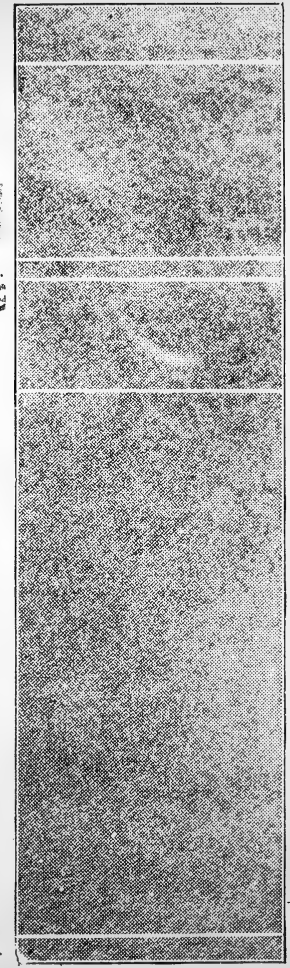


PLATE 49.
100 pounds Rye Shorts—exact volume, 12x12x33.5 inches.

CHAPTER VIII.

BARLEY AND ITS BY-PRODUCTS

More bulky than corn, wheat or rye, less bulky than oats and equally as palatable as either, barley is a grain worthy of more general recognition as a home-grown food for dairy cattle than it receives in this country. It is highly prized in Europe, especially in Denmark, for feeding all classes of livestock, and likewise it is quite largely used in the western coast states of this country.

Where corn matures and yields well barley is not raised for feeding purposes because it is of the same carbonaceous character as corn, its yield is less per acre, and, because of its beards, it is more disagreeable to harvest. Furthermore, when it is grown and harvested, the demand for it has been so great for brewing purposes, provided the kernel is light and plump in color, that the economical method has been to sell the grain and replace it with less expensive feeds.

In analysis barley is very similar to corn, wheat and rye. A comparison of plates Nos. 50, 51 and 52 with those illustrating the feeding nutrients contained in corn, wheat and rye will prove interesting because it will show the close relationship of these feeds as determined by the chemist. Barley leads in mineral matter, carrying 4.5 per cent, or .9 per cent less than oats. It has an added value for feeding dairy cattle because of this.

Barley contains more indigestible material than corn, wheat or rye, but this naturally follows as a result of the greater amount of bulk furnished by the hulls, which also tend to increase the mineral matter.

Compared with corn, wheat and rye, barley contains less digestible carbohydrates. It is richer in protein and much lower in fat than corn and it contains approximately the same amount of fat as wheat and rye and somewhat less protein.

So closely do these feeds resemble each other from the chemist's standpoint that, were there no other factors to be considered, they might well be used interchangeably pound for pound and one would prove equally as advisable to use in compounding rations for dairy animals as the other. In palatability and physical character barley ranks a close second to corn and, in sections where corn does not mature well, barley is suggested as its logical substitute. In fact, the question as to which should be used for furnishing carbohydrates is answered by the availability and cost per hundredweight.

Further than this, every dairy farm should raise some barley. Ground and fed in limited amounts it gives variety to the ration and adds to its efficiency. For special purposes, such as fitting for sale or show, it has a distinct value, especially when boiled and fed mixed with chaffed hay, bran and oil meal. Used in this manner as a substitute for one regular feed daily, or as an extra evening feed, it gives a healthful, glossy appearance to the hair of the animal and insures a soft, pliable, elastic touch to the hide. Like oats, there is a certain value possessed by barley which the chemical analysis does not discover but which is revealed by the animal to which it is fed.

An excellent method of raising barley for feeding purposes is to grow it with oats. Because of its strength of stem it aids in keeping the oats from lodging, and, as almost as large a yield of oats can be secured, the barley will practically be raised extra on the same acreage. Grown in this manner, the high price barley usually brings does not tempt the feeder to sell it. He, therefore, reserves it for feeding purposes. For growing barley in this manner, one or two parts should be sown with three parts of oats.

Feeders who recognize that nearly every summer has its drouth, during which time cows decrease very seriously in milk flow unless there is green feed, now follow the practice of soiling. For this purpose, oats and field peas are largely used and soy beans or cowpeas farther south. In place of oats, barley is well worthy of consideration to be used for soiling purposes. In certain sections it thrives better than oats and it will withstand hot, dry weather better. As barley approaches the dough stage, if it is not cut for soiling purposes, it will make excellent hay for winter feeding.

When the value of barley becomes as fully recognized by breeders of dairy cattle at is now is by breeders and exhibitors of horses and beef cattle, its use will be more prevalent.

Sometimes conditions are such that digestible and palatable carbohydrates can be secured more cheaply from barley than from other home-grown feeds.

Barley By-Products

The chief reason why barley has not been more generally used as a food for dairy cows is because of the high price it has commanded for brewing purposes. In most sections equally good results can be secured from cheaper substitutes. Where this is the case, it is better to sell the barley, using only the less salable portions of the crop. Even as barley is so excellent for feeding dairy animals so are its by-products, and usually they can be secured at prices warranting a judicious use of them.

PLATE 50.
100 pounds ground barley—exact volume, 12x12x36.87 inches.

PLATE 51.
100 pounds ground barley—exact volume, 12x12x36.87 inches.

PLATE 52.
100 pounds ground barley—exact volume, 12x12x36.87 inches.

In the process of malting, barley is first softened in large vats of warm water and then spread out in thin layers and heated to a temperature that will encourage the sprouting of it. This is for the purpose of converting the large amount of starch found in barley into sugar, and, when the highest possible percentage of sugar is developed, the barley is thoroughly dried under steam pressure. The sprouts are then separated from the kernels and are of no further use in the malting process. These are termed malt sprouts, and their chief value is for feeding purposes.

Malt sprouts, as indicated by plate No. 53, are bulky in character; and, because they are kiln-dried, they contain only a small amount of moisture. One of the chief objections to them is that they lack palatability; therefore, they must be considered as an adjunct to rations rather than the principal part of them. When soaked for 10 or 12 hours malt sprouts take up large volumes of water and are an excellent form of succulence when fed in this manner. As shown in plate No. 54, malt sprouts contain a very large amount of ash and mineral matter, and again in this respect their use at the rate of two or three pounds daily per cow is advisable.

Plate No. 55, when compared with plate No. 31 of a previous chapter, illustrates forcibly the feeding value of malt sprouts as compared with bran. Both feeds are high in ash, low in carbohydrates and fat, and of a bulky nature. The chief difference, as shown by the chemist's analysis, is that malt sprouts are much higher in protein, and from this standpoint it would appear they are considerably more valuable. Practical experience, however, does not agree with chemical analysis because animals do not eat malt sprouts with the same avidity that they eat bran, and, therefore, the same response is not to be expected, for palatability is a factor for careful consideration in valuing foodstuffs quite as is chemical analysis.

When fed at the rate of two to four pounds daily mixed with other foods, cows become accustomed to malt sprouts and do not object to their presence in the ration. Their use to this extent is advisable when—as is generally the case—they can be purchased at a price less than bran, because malt sprouts add to the ration protein in a cheap form.

They are one of the most liberal sources of mineral matter, which often is lacking in the dairy cow's ration. They are bulky, and because of this they assist in the digestion of other foods. When succulence is lacking, malt sprouts, thoroughly soaked, serve well the purpose, although they can be fed dry. Other foods can be used for all of these purposes to as good advantage; therefore, the chief

reason why the feeder should give his consideration to this by-product when securing his feed supplies is that it is low in price, and, used in a limited way, may be substituted in part for other foods and to decrease perceptibly the cost of rations, thus making the production of milk and butterfat more economical.

After the malt sprouts have been eliminated from the barley the remainder is known as malt. As the process of beer manufacture progresses, the liquid containing the sugar is extracted. This is the only part of the barley for which the brewer has direct use, and all that remains constitutes another by-product to be disposed of through the most available channels. This by-product is termed wet brewers' grains because, when first the sugar has been taken from them, they are heavily loaded with water. They contain less than 25 per cent of dry matter.

At large breweries there are great volumes of wet brewers' grains, for the small percentage of the barley eliminated in the form of malt sprouts and soluble sugar leaves a large percentage of the original barley in the form of wet grains.

In the wet form, brewers' grains are a most excellent food for the dairy cow. They are very palatable, succulent and stimulating to milk production. The analysis shows them to contain in addition to 77 per cent of water, 1 per cent of ash, 4.6 per cent of protein, 8.7 per cent of carbohydrates and 1.5 per cent of fat. Compared with silage, roots, pasture grasses or other succulent foods, brewers' grains rank much higher in analysis, which illustrates their value to feeders living close enough to the point of manufacture to haul a fresh supply of them daily. Because of their high content of moisture, they can neither be shipped long distances nor held long—unless ensiloed— so that their use in the wet stage is for local consideration only.

In many instances their use by dairymen selling city milk has been prohibited by city milk authorities. This, however, has not been the fault of the brewers' grains, but the fault of the users. Because of their cheapness, feeders are inclined to handle them carelessly and over-feed them. As a result the milk produced becomes tainted, not from the grains that are eaten, but from the portion allowed to remain in the feed boxes, on the feeding floor and around the barn. Naturally, because of their wet nature, they ferment, become putrid, and the air in and about the barn becomes permeated with the objectionable odor, which is certain to find its way into the milk and render it unfit for human food. Care, such as should be practiced in any dairy barn where food, to be consumed in the

raw state, is being prepared for infants as well as adults, will entirely eliminate this objection.

In a western city a few years ago the use of wet brewers' grains as a food for cows producing milk for the city's supply was for a time prohibited because of the belief that children drinking the milk would develop the taste for alcoholic beverages. The fallacy of this action, however, becomes apparent when it is realized that brewers' grains are really more free from this objection than barley, for, in reality, they represent barley with that portion from which beer is made taken away. Therefore, this objection is worthy of no consideration, either on the part of the dairyman or his customer.

Merely because wet brewers' grain can be purchased cheaply is no reason why they should be fed carelessly or why they should be wasted. In fact, because of their wet nature, they should be handled more carefully than dry foods; and, because they are rich in feeding nutrients, they should be fed judiciously. A daily ration of one pound for each pound of milk yielded, up to 40 pounds, will furnish a sufficient amount of succulence, and, fed with 10 or 12 pounds of hay and a grain mixture of ground corn and other carbonaceous foods, this by-product will prove to be an advisable food, because it is a cheap and palatable source of succulence and protein well balanced with carbohydrates, fat and ash. To prove valuable, however, the rule of feeding an abundance of dry matter with it must be closely followed.

Because of the great abundance of the supply of brewers' grains, they usually exceed the demand by large amounts. To find an outlet for them, they are kiln-dried, sacked and offered as dried brewers' grains. Their use is not fully appreciated by the American feeder and they are largely exported to be fed in Europe. Because of the large amount of nitrogen, phosphorus and potash they carry, this exporting process really amounts not only to the loss of an excellent protein foodstuff, but permits the European feeder to draw from this country much of the richness of our barley-growing farms. This is one illustration of how the European farmer encourages his animals to produce more largely and how he increases the richness of his farm year after year; and, likewise, it is an illustration of how the American farmer overlooks his opportunities for encouraging large production and permits the fertility that should find its way to his farm, to be taken over the ocean to enrich a farm there.

Plate No. 56 shows dried brewers' grains to contain a small amount of moisture. Because of this they will keep indefinitely under ordinary storage conditions. They are bulky and palatable, and prove helpful to a ration because of this.

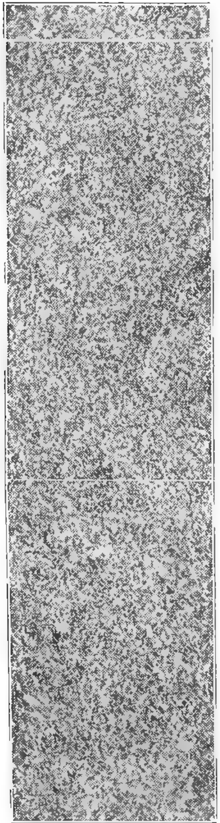


PLATE 53.
100 pounds malt sprouts—
exact volume,
12x12x36.87 inches.

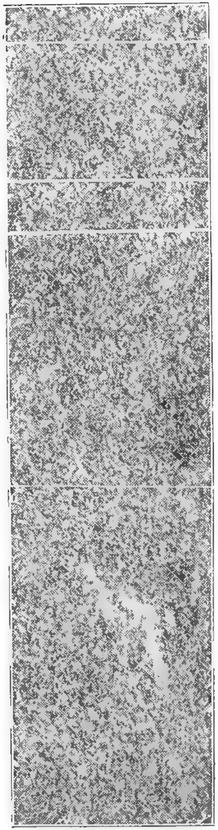


PLATE 54.
100 pounds malt sprouts—
exact volume,
12x12x36.87 inches.

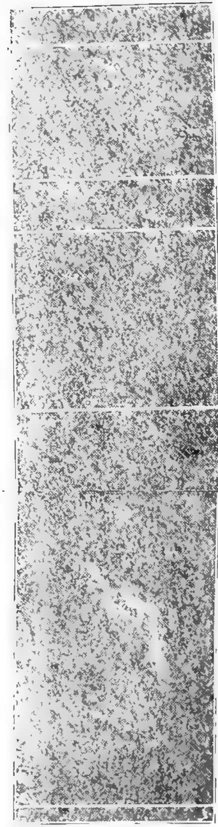


PLATE 55.
100 pounds malt sprouts —
exact volume,
12x12x36 87 inches.

Plate No. 58 shows them to rank well with oats and bran in mineral matter and carbohydrates and to be more valuable for supplying protein and fat. More than this, the practical feeder agrees with the chemist. He finds that dried brewers' grains rank well with bran and are almost, if not quite, equal to ground oats in stimulating milk production and the health of the animal.

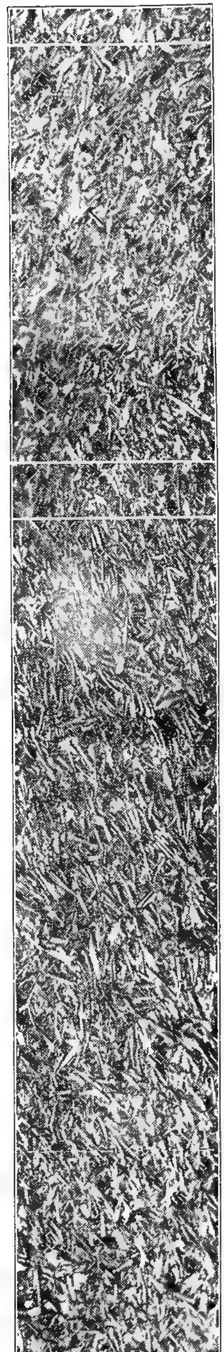
If other succulence is available, brewers' grains should be fed dry, mixed with other concentrates; but, if no other succulence is present, they may be moistened. Their nature is such that they take up large quantities of water and form a most suitable, succulent, palatable, easily-digested food. Their use is advisable and depends upon their cost. Where they can be purchased as cheaply as bran, and from 8 to 10 per cent more cheaply than ground oats, they may well be considered as a part of the dairy cow's ration.

A knowledge of feeds and of their feeding and fertilizing values is of tremendous importance to every farmer. This subject should receive more consideration than it does.

Water,
7.5 pounds.

Dry matter,
92.5 pounds.

PLATE 56.
100 pounds brewers' grains—exact volume, 12x12x61.45 inches.



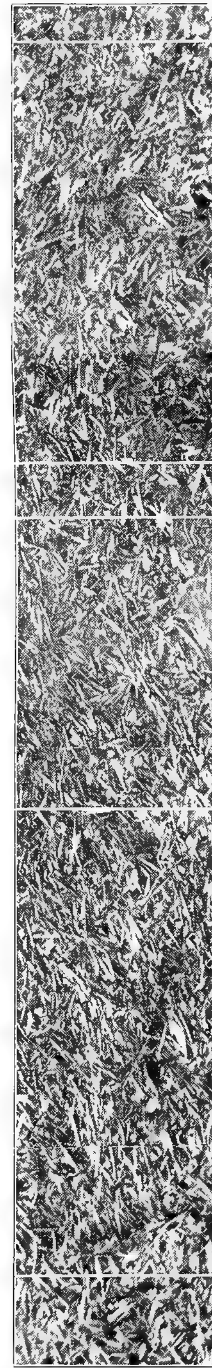
Water,
7.5 pounds.

Indigestible material,
30.9 pounds.

Ash, 3.5 pounds.

Digestible material,
58.1 pounds.

PLATE 57.
100 pounds brewers' grains—exact volume, 12x12x61.45 inches.



Water,
7.5 pounds.

Indigestible material,
30.9 pounds.

Ash, 3.5 pounds.

Protein,
21.5 pounds.

Carbohydrates,
30.5 pounds.

Fat, 6.1 pounds.

PLATE 58.
100 pounds brewers' grains—exact volume, 12x12x61.45 inches.

CHAPTER IX.

DISTILLERS' DRIED GRAINS

Corn, oats, barley and rye are the grains most largely used in the manufacture of whisky and alcohol. Briefly, these grains are ground, softened with water and mashed. At the proper time malt is mixed with the mash, causing the starches of the grains to be changed to sugar. When this is accomplished, yeast is added and the sugar is converted into alcohol. Distilling follows and there remains a residue known as distillery slop. Because nothing has been removed from the grains except starch—which represents only a portion of the carbohydrates—a proportionately large amount of the raw material remains in the slop.

As has been noted in the study of other by-products, the removal of a portion of one nutrient increases the other nutrients, and this is true with regard to the dry matter of distillery slop. By removing a large portion of the carbohydrates, there results an increased percentage of the indigestible material, protein, ash and fat.

In the early history of distilling, the slop was a waste product. Later its feeding value for beef cattle was recognized and extensive feeding lots were installed at all distilleries, and up to now, thousands of steers are finished annually by employing little food other than the slop direct from the distillery. Furthermore, the dairyman who lives close enough to a distillery finds this slop an excellent food for stimulating milk production when fed judiciously with foods that supply the required amount of dry matter necessary for persistency of production.

Having gained knowledge of the feeding value contained in the dry matter of the slop, and desiring to extend the demand for this by-product, many distillers have installed dryers for evaporating the moisture, and when this is done distillers' dried grains with less than 10 per cent of moisture are secured. When the moisture is thus reduced, the grains are sacked and it becomes possible to keep them indefinitely under ordinary storage conditions.

The feeder of dairy cows has been quick to recognize the merits of distillers' dried grains and their use is very general among dairymen. However, it should be remembered that a wide variation exists in their value, according to the raw material from which they are made.

In the manufacture of alcohol, corn is used almost entirely and the grains from this source are known to be of highest feeding value. When whisky is distilled, the grains rank in value according to the percentage of corn used, therefore, those grains resulting from the distilling of rye whisky are of the lowest feeding value because very little corn is used.

With these facts in mind, the feeder is enabled to select distillers' grains according to their feeding value, which, when portrayed by guaranteed analysis, will show them to vary in content of protein from 33 per cent in the very best grade to 14 per cent in the very poorest. This feature is not objectionable to the buyer who purchases feeds with regard to their real feeding value because he pays for a feed in accordance with its analysis, and he varies the amount of each food when mixing rations according to the nature of the feeds available, and the needs of each cow.

Distillers' dried grains are not palatable to cows. They have a peculiar, sour taste and smell which vary according to the length of time fermentation has been permitted to continue before the moisture is evaporated from the slop. This is not a serious objection. Cows soon become accustomed to the taste and eat the grains with much relish. Then it is found that the sour taste has a tendency to sharpen the appetite, and the objectionable feature becomes a favorable factor.

As shown by plate No. 59, these grains are very light and bulky, comparing favorably with bran in this respect. Because of this, they can be fed heavily with little danger of harming the animal, and it is for this reason that those who feed for large records use them very extensively in substitution for foods of a like feeding value that are less bulky.

Compared with bran and various other bulky foods, it will be seen by plate No. 60 that distillers' dried grains are largely digestible, there being in 100 pounds of the feed 74.4 pounds of digestible material. The large ash content is also a useful factor and the 16.4 pounds of indigestible material being of a flaky, bulky nature adds to, rather than detracts from, the merits as a foodstuff for ruminating animals.

In analysis, the grains, if of a superior quality, rank high in the scale of food values. This is especially true of the content of digestible protein and fat as illustrated in plate No. 61. Because of the large amount of digestible protein and fat, combined in a feed so bulky in character, only good results are to be expected where its use is employed in accordance with the demands of the cow. In the hands of the practical, experienced feeder, distillers' dried grains

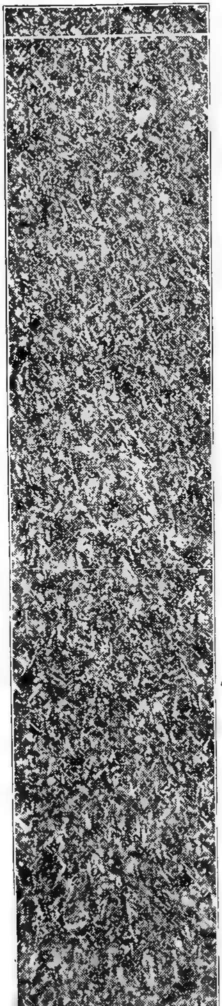


PLATE 59.
100 pounds dried distillers' grains— exact volume, 12x12x46 inches.

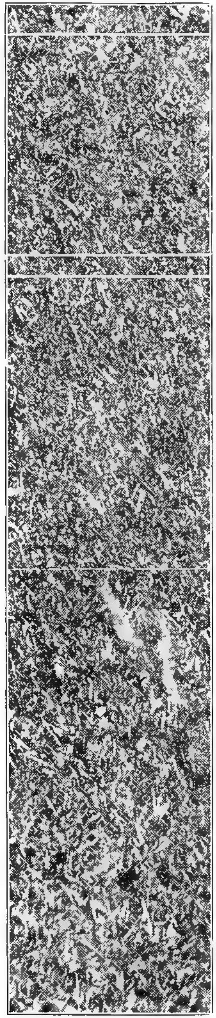


PLATE 60.
100 pounds dried distillers' grains— exact volume, 12x12x46 inches.

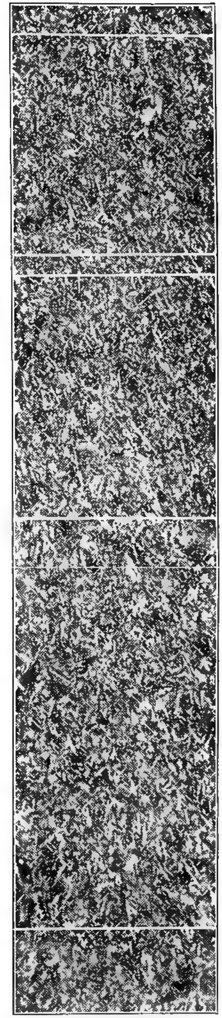


PLATE 61.
100 pounds dried distillers' grains— exact volume, 12x12x46 inches.

have stood the test and meet with favor when they can be purchased at a price which warrants their use in comparison with other foods.

At several experiment stations they have proved their worth. Armsby and Risser of Pennsylvania found from experiments that when five and one-half pounds of the grains were substituted for three pounds of cottonseed meal and two and one-half pounds of corn meal a slight increase in milk flow resulted and the percentage of fat was increased. It is not usually believed possible to increase the percentage of fat in milk by the use of feed, yet in this instance, as in others, it occurred when distillers' dried grains were used. The explanation for this is that the increase in butterfat was a result of the high content of fat present in the grains. A later experiment at the Vermont Experiment Station indicates like results, although the percentage of butterfat was not increased as largely as in the Pennsylvania test.

Although the ration consisting of corn meal and cottonseed meal was less expensive than the distillers' dried grains ration, the extra yield of milk and butterfat was sufficient to warrant the extra cost and render the distillers' dried grains ration superior for greatness of production and practically equal from the standpoint of economy.

That this foodstuff ranks well with protein feeds is a certainty, and, where it can be secured, its use is to be highly recommended. It is a fact that those mixed, commercial feeds the basis of which is distillers' dried grains are among the best on the market and, seemingly, the larger the percentage of distillers' grains used the better is the feed.

CHAPTER X.

COTTONSEED MEAL

Not many years ago cotton seeds were considered valueless. They constituted a waste product to be disposed of at an expense or left in a pile at the gin to rot. When it became known that the seeds were a source of valuable oil mills sprang up all over the south and two extensive industries were born. Today the value of cotton seeds is such that they represent a large source of wealth to cotton-growing sections.

Machinery has been provided for removing the lint and the heavy hulls the seeds wear, thus releasing the kernels that contain the oil and the nutrients which represent the feeding value. These kernels are ground, heated, confined between cloths and subjected to sufficient pressure to squeeze out the oil. That which remains is cottonseed cake, and in this form much of it is exported to Europe. In fact, the European feeder appreciates the feeding value of this useful by-product more than does the American feeder, and, furthermore, he demands the cake instead of the meal for he prefers to grind it himself rather than risk the possible infusion of adulterants which often gain access to the meal when others grind it.

Now that the gasoline engine and the electric motor are becoming so common on the American farm, the feeder of this country can well afford to consider purchasing his linseed and cottonseed feeds in cake form, installing a small grinder and reducing them to meal on his own farm. The advantages to be gained in so doing are as follows: First, the adding of adulterants is made impossible. Second, the cost of sacks and sacking is eliminated. Third, by grinding frequently, a fresher, more palatable food is provided and the liability of molding and spoiling is reduced to a minimum. Fourth, from $2 to $5 per ton can be saved on the purchase price by purchasing the cake rather than the meal, and a superior food is secured while the labor of grinding is small.

Although the value of cottonseed meal is universally known in this country, it is not so largely used as it should be, else the hundreds of thousands of tons commonly exported to other countries would be fed at home.

Disregarding the feeding value of it for a moment and considering its fertility value, a strong factor favoring its use becomes apparent. With nitrogen, potassium and phosphorus scarce and expensive, it must be considered by the American feeder that all

cottonseed meal shipped abroad takes from this country fertility which makes the farms of Europe richer and the farms of the United States poorer.

As the knowledge of agriculture advances and the necessity of conserving the fertility of farms becomes more apparent, more cottonseed meal will be fed at home and less exported. If the feeder of Europe can afford to pay freight on cottonseed cake from the mill to seaboard and across the ocean, the farmer of this country can afford to feed it to dairy cows when the butter he produces sells at a price as high as, and in many instances higher than, is secured by the European dairyman.

As a rule, cottonseed meal, if unadulterated with hulls, is one of the very cheapest sources of protein. It is very palatable, and cows eat it with more avidity than they do most by-products. Cottonseed cake cracked into pieces the size of a hazel-nut is even more palatable and less wasteful to feed.

Cottonseed meal, being very concentrated in form, should be fed with foods that are more bulky in order to derive its greatest value. It is especially desirable to feed to cows on grass or those eating silage because it counteracts the over-laxative effects of these succulent feeds. When all other feeds used are dry, oil meal is preferable.

When cottonseed meal first came into general use, serious results became common. Steers eating it became blind and the hogs following them died. Udder trouble followed its use in the dairy-barn and calves to which it was fed died. Most of these troubles, however, were the direct result of the cheapness of the feed and the injudicious manner in which it was used.

As a feed for small calves and hogs cottonseed meal is not to be advised, for, even though they may eat small quantities of it and live, they will thrive better on other rations. As a food for beef cattle cottonseed meal has proved one of the best when used at the rate of two or three pounds daily throughout a short feeding period. For dairy cows cottonseed meal finds its greatest value, and, although it is advisable to use it in a limited manner or at the rate of two or three pounds daily, it may be fed more heavily without serious effects to cows yielding largely.

In any dairies where immediate economic milk production is the sole aim cottonseed meal mixed with silage and fed in conjunction with hay provides the entire ration, but this method is not to be advised where best results over a period of years is sought.

As shown by plate No. 63, cottonseed meal contains 6.2 pounds of ash in each 100 pounds, and because of this it is an excellent source

Water,
7.5 pounds.

Dry matter,
92.5 pounds.

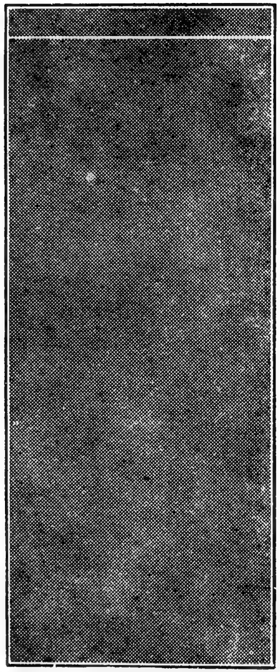


PLATE 62.
100 pounds cottonseed meal—
exact volume,
12x12x23.05 inches.

Water,
7.5 pounds.

Indigestible
material,
18.9 pounds.

Ash, 6.2 pounds.

Digestible
material,
67.4 pounds.

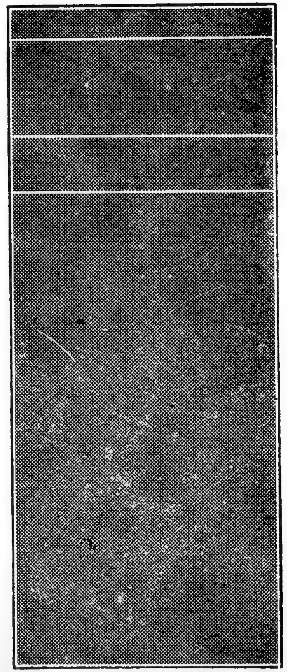


PLATE 63.
100 pounds cottonseed meal—
exact volume,
12x12x23.05 inches.

Water,
7.5 pounds.

Indigestible
material,
18.9 pounds.

Ash, 6.2 pounds.

Protein,
37 pounds.

Carbohydrates,
21.8 pounds.

Fat, 8.6 pounds.

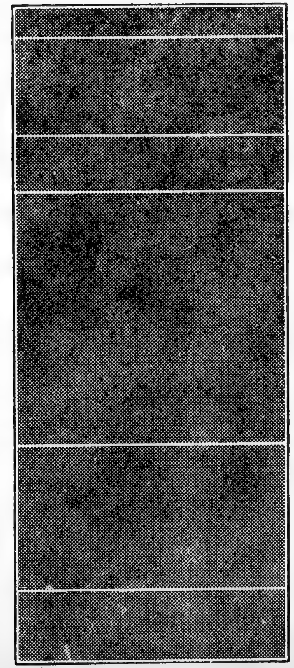


PLATE 64.
100 pounds cottonseed meal—
exact volume,
12x12x23.05 inches.

of mineral matter. Being largely digestible, as plate No. 63 also illustrates, there is very little waste; but, on the other hand, the cow will not use it to best advantage unless mixed with other and more bulky foods. It is because of this fact that oftentimes, although analyses do not indicate the possibility, better results are secured from such foods as distillers' dried grains, dried beet pulp, and other foods lighter in character.

The real value of cottonseed meal is portrayed by plate No. 64, but it is well to remember that only the choicest cottonseed meal contains so large an amount of digestible protein per hundredweight as 37 pounds or as much digestible fat as 8.6 pounds. It is because of this high content of protein and fat that the feeder, whose home-grown feeds are so largely carbonaceous, purchases cottonseed meal. Therefore, he should insist on securing only the choicest grade, or that which contains the smallest percentage of ground cottonseed hulls, which nowadays are often found in abundance in some meals.

Cottonseed hulls rank lower in feeding value than straw, which fact proves conclusively the folly the feeder of the north pursues in paying freight on them mixed with otherwise pure cottonseed meal. In the south the hulls are useful, for they contain broken seeds, and, therefore, have a certain feeding value. Because they are carbonaceous and bulky in character and because, when fed in limited amounts, they are palatable to the cow, their use is to be recommended much as is the use of straw, timothy hay and corn stover in the dairy of the corn belt.

It is for the same reason that cold pressed cottonseed cake, although a valuable foodstuff, is worth less to ship north than the pure cottonseed meal or cottonseed cake.

The cold pressed cake results from pressing oil from the entire cottonseed without heating or grinding, and, therefore, a large percentage of the hulls remain in the resulting by-product. It is also true that a larger percentage of oil remains, causing the residue to contain a higher percentage of fat and carbohydrates but a lower per cent of protein.

At the Louisiana Experiment Station it was found to be worth somewhat less as a food for dairy cows than a mixture of two parts meal and one part hulls. Reduced to the dollar basis, it was estimated that with cottonseed meal available at $30 per ton cold pressed cottonseed cake was worth $21.65 per ton.

Fed judiciously, cottonseed meal of good quality is one of the most valuable of foods for cows, and on every farm where cows are milked some cottonseed meal should be used. It is a cheap source of protein in a form that is palatable to the cow and stimulating to

milk production. Because of its high percentage of protein and its low percentage of carbohydrates, its use renders simple the task of balancing rations. For these reasons, it is used largely by manufacturers of commercial mixed feeds.

Many dairymen have herds so small that they hesitate to buy cottonseed meal and other feeds in carlots. In such instances, neighbors, or members of local associations, should co-operate in buying because, considering differences in carlot and local freight rates as well as wholesale prices, a great saving can be made.

CHAPTER XI.

ROOT CROPS

Continuously we of the Western Hemisphere go to Europe for breeding animals. For some reason or other it seems that, to keep our livestock up to a desired standard, it is necessary to infuse new blood from its natural source into the veins of our breeding stock.

There are various reasons why this condition prevails, but the three most certain are that we do not combine blood lines with the same intelligence that the breeder of Europe does; we do not care for our animals with the same methodical, sympathetic expertness of the English and Scotch; and we do not feed in the same manner.

Until the silo became so common very few animals in this country received any succulent food from the time grass withered in the fall until it sprang forth in the spring, and then, as a rule, animals found themselves during a month of drouth every summer with only dry grass—and little of that—to nibble. Largely because they were kept on dry grain, usually carbonaceous in character, and hay, largely timothy, animals lost that sappy condition so characteristic of imported stock, and this, together with common care and careless mating, made it necessary to renew the blood often, regardless of expense.

That roots are valuable for feeding purposes has never been a secret, and the old-country feeder, who came to America to serve a master who wished to excel in the dairy or show ring, insisted on a supply of beets or mangels with which to winter his charges and to condition them in the fall. That he was right in his belief that roots were useful was invariably proved when the results of the contest were announced.

Even in this day, when silos are nearly as prevalent as corncribs and hay barns, the man who wins most successfully at our shows or takes the cow to the farthest goal of butter records is an ardent advocate of roots, and he uses them liberally.

Just wherein lies their value the chemist has never been able to discover because, as plate No. 65 vividly shows, water is the chief ingredient of the sugar beet as well as other roots. Why water found in roots is more valuable than that drank from a tank in the barn lot or a basin at the stall is not well known, yet it is conceded that roots are more easily digested than dry feeds; they assist in the digestion of other foods by giving healthful tone to the digestive apparatus;

they act as a tonic, thus saving veterinary bills; and they stimulate a vigorous appetite.

These are points worthy of the careful, thoughtful, serious consideration of every feeder, breeder or dairyman, and, yet, an almost unsurmountable obstacle precludes the raising of them in a manner as extensively as they are raised in European countries. These lands are high in price and labor plentiful. Here lands are comparatively cheap and labor scarce. Try as we may, on the average farm, to raise root crops, the weeds take them. As the Scotchman said when he visited this country, "The American quarreled years ago with the hoe, and the difference has never yet been adjusted." Roots cannot be successfully raised without the liberal use of the hoe employed at just the right time.

Conditions are changing rapidly, however. Lands are increasing in value; boys are becoming more inclined to remain on the farm; there is under way a tendency for the crowded city to send her surplus to the country; grains, grasses and all foodstuffs are increasing in price, so it may not be long before the tiller of the soil of this country will renew friendship with the hoe and raise, on a part of his farm, roots that will yield a great tonnage of choicer feed than any other crop.

If every cow in the United States were to receive one 20-pound feed of roots daily, from November to May each year, we would raise better cattle and produce better calves than we do under prevailing methods. This is true even where silage is fed, and doubly true where it is not.

At the present time the great expense incurred in raising and harvesting root crops prohibits their use as compared with corn silage or dried beet pulp except for special purposes, such as fitting animals for show, or sale, for testing them for butterfat records or for substituting for grain rations.

Prof. H. H. Wing, experimenting at Cornell University Experiment Station, drew the following conclusions after an extensive test conducted to determine the possibility of using roots instead of high-priced grains for feeding dairy cows:

Less dry matter was required to produce one pound of butterfat when mangels were fed as a succulent food with a full grain ration than with any other combination.

The average cost of one pound of butterfat under all conditions was 22.4c.

The lowest price at which a pound of butterfat was produced was 20.7c, with ration I (hay, grain and silage).

The cost of one pound of butterfat with ration II (hay, grain and mangels) was 27.4c. This was considered too high to be economical.

The cost of one pound of fat with ration III (hay, grain, mangels and silage, grain ration reduced one-half by substituting mangels) was 20.75c. Since the cost of one pound of fat in the check group averaged for the two years 20.6c, ration III was considered economical.

One pound of dry matter in mangels is a little more than equal to one pound of dry matter in silage. One pound of dry matter in mangels is equal to one pound of dry matter in grain and mangels may replace one-half the ordinary grain ration with mixed hay and silage.

Accepting the average price of commercial feeding stuffs at $30 per ton, and considering one pound of dry matter in mangels equal to one pound of dry matter in grain mangels may be used economically in the ration to replace one-half the grain ordinarily fed when they can be produced and stored ready for feeding at $4 per ton. In arriving at this conclusion, the average amount of dry matter in grain is considered to be 90 per cent, and in mangels to be 12 per cent.

It would seem to be safe assumption that farmers can raise mangels for $4 per ton and thus reduce their feed bill very materially by the judicious use of mangels to replace one-half of the grain ordinarily fed in the rations.

A possible explanation of the value of roots is suggested by plate No. 66, which shows the small amount of indigestible material contained in 100 pounds of sugar beets; but, again, plate No. 67 causes one to wonder at the possibility of roots being substituted for grain when there is contained in 100 pounds of sugar beets only 1.2 pounds of digestible protein, 12.8 pounds of carbohydrates and .1 of a pound of fat.

In his bulletin Professor Wing quotes from experiments, made at the Ohio Experiment Station by Thorne, Hickman and Falkenbach, the following results, which show conclusively why, under present conditions, root crops are not more generally used, and why, for several years, they will be raised for special purposes only.

The feeding of beets to milch cows increased the consumption of other foods and of total dry matter.

Beets always increased the flow of milk and the total yield of butterfat, but this increase has never been sufficient to offset the additional consumption of food.

Water,
83.6 pounds.

Dry matter,
16.4 pounds.

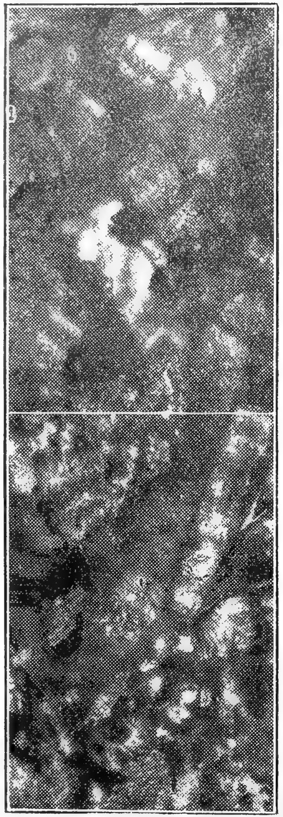


PLATE 65.
100 pounds sugar beets—
exact volume,
12x12x40.85 inches.

Water,
83.6 pounds.

Indigestible
material,
1.4 pounds.
Ash, 1.1 pounds.

Digestible
material,
13.9 pounds.

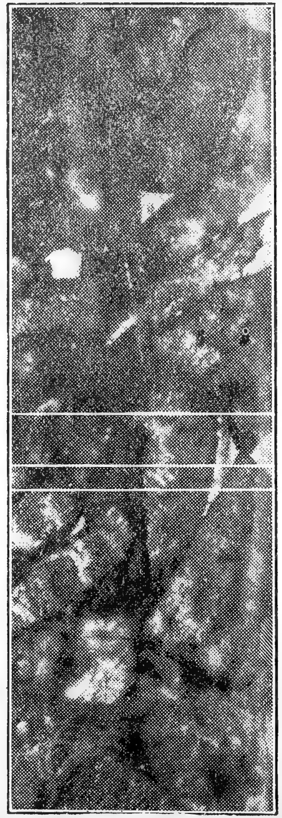


PLATE 66.
100 pounds sugar beets—
exact volume,
12x12x40.85 inches.

Water,
83.6 pounds.

Indigestible
material,
1.4 pounds.
Ash, 1.1 pounds.
Protein,
1.2 pounds.

Carbohydrates,
12.6 pounds.

Fat, .1 pound.

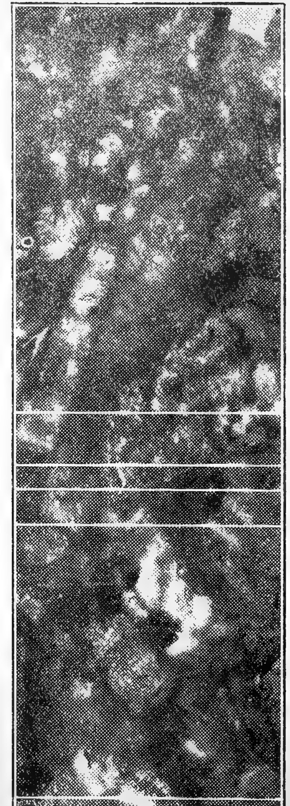


PLATE 67.
100 pounds sugar beets—
exact volume,
12x12x40.85 inches.

Cows fed on beets showed an increase in live weight, while those fed on silage remained about the same.

Beets did not increase the amount of water drank, although fed in such quantities as to increase the water content of the food 30 pounds per day.

The experiments did not justify the assumption that the dry matter of beets is any more effective, pound for pound, than the dry matter of silage made from well-matured corn containing 13 to 18 per cent of grain.

In the region where the tests were made, and at the average of 10 years' culture of corn and field beets side by side, two pounds of dry matter was produced in the form of corn silage at a less cost than one pound of dry matter in the form of beets.

A question was suggested by the experiments as to whether beets might not be used to advantage in comparatively small quantities, fed as appetizers. While silage made from comparatively mature corn showed best results in general, the experiments suggested that the silage should be made before the corn has reached full maturity.

CHAPTER XII.

DRIED BEET PULP

During the period intervening between 1878 and 1915 the amount of beet sugar produced in the United States annually grew from 100 tons to 413,954 tons.

The people of the United States consume annually 77.54 pounds of sugar per capita, which is more than double the average amount consumed per capita in all Europe. In round numbers, 3,800,000 tons of sugar are used in this country annually, while the combined production of cane and beet sugar is less than half that amount. That which is not produced at home must be imported, which, in the face of the success attained in various parts of the United States in producing both cane and beet sugar, seems just as ill advised as the exporting of valuable fertility-carrying foodstuffs which should be fed to farm animals at home.

Where beet sugar factories are located and properly operated, farmers find the raising of beets very profitable, and learn that the wet beet pulp, which is a by-product of the sugar factory, is a most excellent, succulent, palatable food that is extremely stimulating to large and economical milk production.

When the beets are pulled and topped the farmer hauls them to the factory, where they first pass through several water baths and are scrupulously cleansed. The next process is to pass them through a series of knives, which reduce them to long shreds no thicker than a common lead pencil. The shreds, or cosettes, as they are called, pass through a number of cylinders or cells in each of which they are treated with hot water, which washes out the sugar. When this process is completed, the sweet liquor is drawn off and the residue, or wet beet pulp, is expelled in large piles to be hauled to adjacent farms, fed at the factory during the winter to fattening steers, or preserved in huge silos.

Where factories are sufficiently prosperous, much of the surplus water is pressed from the mass and the remainder, except 8 or 9 per cent, is eliminated by kiln drying.

Fortunate, indeed, is the dairyman who lives close enough to a sugar beet factory to be able to haul the wet pulp daily to his farm for feeding purposes. As a means of encouraging farmers to raise beets, many factories furnish the wet pulp in abundance free for the hauling; others charge a nominal fee of 50c per load. Because this wet pulp contains all the nutrients of the sugar beet except the sugar,

Water,
8.2 pounds.

Dry matter,
91.8 pounds.

PLATE 68.
100 pounds dried beet pulp—
exact volume,
12x12x46.09 inches.

Water,
8.2 pounds.

Indigestible
material,
17.7 pounds.

Ash, 3.5 pounds.

Digestible
material,
70.6 pounds.

PLATE 69.
100 pounds dried beet pulp
exact volume,
12x12x46.09 inches.

Water,
8.2 pounds.

Indigestible
material,
17.7 pounds.

Ash, 4.3 pounds.

Protein,
4.6 pounds.

Carbohydrates,
65.2 pounds.

PLATE 70.
100 pounds dried beet pulp—
exact volume,
12x12x46.09 inches.

its value approaches the value of the original beet, and the cost is so small that, where judgment is used in feeding, its use renders the cost of milk production small.

Contrary to the general opinion, the pulp, even though piled carelessly in large piles, can be fed all year. It sours slightly but does not spoil, and, when it has fermented, cows eat it, seemingly, with more relish than when the pulp is fresh, and the results from the standpoint of milk production are equally favorable.

As is usually the case when any feed is very cheap, wet beet pulp is liable to be overfed. The dairyman is encouraged to increase the amount from day to day as his cows become accustomed to it, because they like it better than any other feed, and with each increase there comes an increase in milk flow. If given all the wet pulp they will eat, cows care little for hay and grain and apparently do not eat enough dry matter to protect their bodies and provide for the unborn calf. As a result, the calf when born very often is in a weak, emaciated condition, predisposed to scours, and often does not live. This is not the fault of the beet pulp but is due to injudicious use of it. To secure the best results, the feeder should watch closely the daily ration of each cow, from which he would raise a strong, vigorous calf, and make certain that she eats a sufficient amount of hay and grain to protect her own body and that of her unborn offspring from emaciation.

Accurate results secured from the use of the wet beet pulp for feeding dairy cows at the Cornell University Experiment Station are as follows:

The cows, as a rule, ate beet pulp readily and consumed from 50 to 100 pounds per day, according to size, in addition to the usual feed of eight pounds of grain and six to 12 pounds of hay.

The dry matter in beet pulp proved to be of equal value, pound for pound, with the dry matter in corn silage.

The milk-producing value of beet pulp as it comes from the beet sugar factory is about one-half that of corn silage.

Beet pulp is especially valuable as a succulent food, and, where no other such food is obtainable, it may prove of greater comparative value than is given above.

Excellent as is the wet pulp for feeding purposes, dried beet pulp is better. It is more convenient to feed, can be mixed with other rations—either dry or moistened—and is not so liable to be overfed.

In the sugar factory when the sweet liquor is withdrawn the beet shreds pass directly to the drying kiln before any fermentation has taken place, and within one hour the moisture has been reduced to a minimum and a palatable, bulky, easily digested food is sacked preparatory to storage and shipment.

It is interesting to compare the accompanying plates with those illustrating the feeding value of sugar beets and note the great change in the bulk, moisture and content of nutrients occasioned by extracting the sugar and water from the original beets. Plate No. 68 shows vividly the increase in bulk and dry matter at the expense of the moisture contained in the sugar beet. By taking away the water and sugar, plate No. 69 shows the enlarged amount of indigestible material and ash, and, by comparing plate No. 70 with plate No. 67 it will be readily noted how the protein and carbohydrates have been increased and the trace of fat present in sugar beets has been entirely eliminated by the process.

Dried beet pulp is especially palatable to cows, and, being bulky, it proves an excellent addition to almost any ration. Practical feeders find that, like roots of various sorts, it proves more valuable than the chemical analysis would indicate. This is, no doubt, due to the fact that the original value of the sugar beet is retained, and, therefore, the belief is encouraged that the American feeder can secure equally good results by using this useful dried beet pulp as the European feeder secures from raising and feeding beets and mangels.

When silage or other succulent food is available in abundance dried beet pulp can be fed without moistening at the rate of from three to five pounds daily.

One of the readers of Kimball's Dairy Farmer has advised us that, because of the poor quality of hay at his command, he is substituting five pounds of dried beet pulp for seven and one-half pounds of hay and securing excellent results.

One of the great values of dried beet pulp is that of furnishing succulence to a ration in the absence of other watery foods. When used in this manner, it serves a double purpose—that of supplying food nutrients and adding succulence. Exhibitors of show cattle find it a most serviceable feed because they can carry it with them and soak it with water whenever succulent food is needed, and thereby avoid the inconvenience of locating roots or silage at each of the fairs at which they exhibit.

At the New Jersey Experiment Station it was found that with corn silage valued at $4 per ton and dried beet pulp at $20 per ton milk could be produced 3.31 per cent cheaper and butter for 3.48 per cent less by using silage instead of the pulp. This suggests that it may be better to use dried beet pulp in conjunction with silage rather than substituted for it. As a further proof of this, it was found that when molasses beet pulp cost $20 per ton the dried beet pulp substituted for it in the grain ration produced milk at a saving of 3.09 per cent and butter at a saving of 4.7 per cent, showing dried

beet pulp to be superior to the molasses beet pulp. But, when molasses beet pulp was substituted for hominy feed at $23 per ton, which feed is equal to corn meal in feeding value, it was found that milk was produced for 6.02 per cent less cost and butter at a saving of 6.3 per cent. This would indicate that dried beet pulp is a much more economical feed than hominy feed when the comparative prices are in the ratio of $20 per ton for the former and $23 per ton for the latter.

Valuable as is hominy feed on every dairy farm, it is especially valuable where the aim is to make large milk and butter records and in those sections where protein feeds are plentiful and either succulent foods or those rich in carbohydrates are scarce.

CHAPTER XIII.

MIXED FEEDS

Classed with foods known as concentrates are various mixed feeds, many of which are proving so satisfactory in general use that they have become as staple as grains and even more staple than many of the by-product feeds.

Much prejudice has in the past centered about mixed feeds. Experiment stations and writers have been slow to recommend the use of these commercial mixtures. The one real, well-defined reason for this is because many of those who manufactured such feeds in former years either lacked the knowledge necessary to compound a feed that was at once economical and useful, or their consideration was given more largely to making quick profits for themselves rather than sure profits for those who purchased their feeds.

Waste products of various sorts, such as ground corn cobs, weed seeds, oat hulls, cottonseed hulls, etc., were used as fillers and as such constituted a large percentage of the mixture.

With the filler was mixed certain percentages of feeds useful in feeding value and of a palatable nature, so the final food would be readily eaten. Extravagant claims were made for such feeds, and, even though large prices were exacted for them, extensive sales were made.

The more useless the mixture the louder its supposed virtues were heralded and the larger its sales in many vicinities. Furthermore, there seemed to be the unscrupulous in every community who were capable of selling the unsuspecting feeder a ration compounded by a certain secret process from mysterious roots, herbs, grains, etc., which, without a doubt—although necessarily it was quite expensive—would do wonderful things for him who would believe and through faith buy a ton or a carload and feed it to his animals. It was good for all classes of animals but best for the kind of which the farmer had the greatest number.

Quite naturally there were hundreds of disappointed feeders. The silver-tongued salesman could convince them of the merits of his feed, but the farm animals were traitors. They would not bear evidence favorable to his claims.

Those manufacturers who were sincere in their efforts to furnish an efficient mixed feed suffered, because the same honesty that impelled them to put value into their products prohibited them from

making dishonest claims of the results the feeder might expect. A peculiar condition existed.

Experiment station chemists began analyzing these various feeds and exposing the true composition of them. But, as rapidly as one feed was thus disposed of another sprang up to take its place. Finally a general distrust in mixed feeds became prevalent and the honest manufacturer was compelled to suffer with and because of the unscrupulous competitor.

To cope with the situation and protect both feeder and honest mixed feed manufacturer laws were passed in various states which made it compulsory that every sack of feed, other than the natural grains, be branded with the true analysis of its contents. Most states have, through their pure food departments, enforced these laws in a most commendable manner, so that feeds are no longer purchased on a basis of some peculiar, mysterious effect they will have upon the animals to which they are fed. They are sold on the basis of the actual food nutrients and crude fibre contained in them. Because of this the feeder whose knowledge leads him to buy protein, carbohydrates, fat and mineral matter in a form at once palatable, easily digested and reasonable in price is in a position to use his own judgment and make as wise a selection of food as anyone.

So strict have the feed laws been that very often it is now true that commercial feeds really contain a higher percentage of protein and a lower percentage of crude fibre than their guaranteed analysis shows. There is naturally a very wide variation in feeding values of one and the same food. This is even more true of grains and hays than it is of by-product foods and mixed feeds.

When first harvested, because of the large amount of water present, the percentage of dry matter and the feeding nutrients are comparatively low. As feed dries, these nutrients increase in direct ratio to the decrease in moisture content.

Again, a sack of ground feed may analyze uniformly the same from top to bottom when it leaves the mill, but, through handling in transportation, the heavier parts may settle to the bottom, causing a much different analysis for one part of the sack than the other parts when it finally reaches the feeder. This is even more true of carloads of feed when shipped in bulk.

Furthermore, to analyze every ton of feed leaving the numerous large mills of this country would involve a great expense and the services of an army of chemists. To simplify the process, millers and manufacturers are inclined to employ a factor of safety and label the feed they offer for sale with a guaranteed analysis low enough so it will be sure to pass inspection favorably. In other words, feed dealers are now compelled by law to underestimate the value of

their feed, if they would be safe, rather than attach to them the extravagant claims which formerly were so customary. This is the convenient thing for the manufacturer of by-products to do.

Bran, linseed meal, cottonseed meal, etc., have become well-known, staple products. During the milling season the average analysis is obtained from time to time, and sacks are labeled according to the variation which exists. But the manufacturer of mixed feed has found that a certain analysis secures the best results, and he realizes that satisfied customers are his best advertisements. He realizes that to succeed he must maintain a uniform quality and composition in his feed. He uses the various by-products as well as ground grains in his process of manufacture.

To uphold the standard he has set for his feed it is necessary for him to analyze, not only every carload of foodstuffs he buys, but, because of the variations of analyses in one and the same car, he must take samples from various parts and determine the exact feeding value of each. The results thus secured by his chemists tell him how to mix the feed—what proportion of each to use to insure that, when finally his special brand of feed is made, it will be up to its usual standard. This is one great advantage the mixed feeds of today have over all other feeds. If a commercially mixed food is good at all, it is uniform in quality at all times and can be depended upon.

Under present conditions it is the business of the manufacturer of mixed feed to mix the very best feed possible in the most economical manner. He makes it his business to contract for the purchase of the constituent parts of his feed when these can be bought cheapest; and, instead of buying in 100-pound lots, ton lots, or even carload lots, he buys by the trainload, thereby availing himself of the most reasonable prices. Very often, because of this, the feeder is enabled to secure in certain mixed feeds a ration that is always uniform in character, containing exactly the essentials for large production, more cheaply than he can secure the same nutrients from other sources.

The present day manufacturer of mixed feeds is, as a rule, a close student of feeding problems. He has a keen knowledge of food values, the analysis of foods, their digestibility, and the physical character of each. With the assistance of his chemists, he is enabled to mix a more uniformly well balanced feed than is the farmer. Being so extensive a purchaser, he is enabled to secure more cheaply the various grains and by-products that constitute his feed than the local feed dealer who purchases only in carlots as the demand asserts itself. With his machinery he can mix feed cheaper and more thoroughly than it can be done on the farm with a scoop shovel.

These are a few of the factors that make it possible for the wholesale feed-mixer to be a true friend of the feeder, and rapidly his services are being appreciated even by the extensive feeder who purchases in carload lots.

Of greater service still is this manufacturer to the small feeder. Variety is one of the chief essentials of a successful ration. To buy to the best advantage necessitates buying in carlots. This not only secures a wholesale rate but makes a saving in freight rates. The feeder who can use only one carload of feed at a time must buy small amounts of various feeds at relatively higher prices if he would mix these himself. One carload of mixed feed properly selected, on the other hand, furnishes a variety of food, as well as the nutrients he desires. To such a feeder the knowledge, efficiency and services of a wholesale mixer are most valuable.

Because it is to the advantage of the manufacturer of mixed feeds, he considers the needs of his customers. In some sections an abundance of carbonaceous feeds are raised on farms, while in other sections protein foods are grown almost to the exclusion of carbohydrate foods. Therefore, according to the locality in which the feed is offered for sale, manufacturers mix foods rich in protein or in carbohydrates so that they can be used to the best advantage for balancing farm-grown grains and roughages.

Surely there are many economic reasons why the wholesale mixer of feeds should be able to co-operate with the feeder to the advantage of each other. In thousands of instances this is being accomplished. In other instances conditions are yet such that the feeder is warranted in mixing his own feed, because he possesses a knowledge that enables him to do so efficiently, and because he is so located that he can purchase the parts of a ration and mix them himself more cheaply than he can buy them ready mixed.

With these facts in mind the feeder will do well to lay aside prejudices, study the conditions on his own farm and determine in a systematic manner just what it is necessary for him to secure to perfect the ration he would feed his cows. When he knows and realizes definitely what he needs he is in a position to make selection intelligently. He can then go on the market, either personally or through correspondence, and determine a most advantageous source of supply.

If, after investigation, he finds it is more economical for him to secure the feeding nutrients his home-grown feeds lack by purchasing by-product feeds and mixing them himself, it is to his advantage to do so. On the other hand, if he finds that his needs can best be supplied by one or more of the commercially mixed foods, and that by their use he can make a saving in the cost of his ration,

as well as a saving in the labor required for mixing feed on the farm, then certainly it is to his advantage to use the mixed feed which he will nowadays find up to the standard of guaranteed analysis and uniform in composition.

There are so many mixed feeds on the market, most of them using as a basis the grains and by-products which have already been discussed, it is almost. if not quite impossible for us to deal with them individually as we have with the grains and by-products. The knowledge possessed, however, of the feeds that have been considered in detail will enable the feeder to determine by comparison the value of any one of the various mixed feeds.

CHAPTER XIV.

SILAGE

Practical experience and scientific experiments have demonstrated conclusively to the student of feeding problems and to the feeder of livestock that succulence is essential in the ration. True as this is in the feeding of all classes of livestock, it is especially true with regard to feeding dairy cattle. This is one point about which doubt no longer exists. And, many years before it became a settled fact in this country, it was well known and universally recognized by the farmers of Europe.

Had the method of furnishing succulence in the older countries been by the use of the silo, this useful structure would have come more rapidly into general use here because the feeder has long recognized the expertness of the European livestock breeder and feeder and realized that succulent foods have been a great aid to them.

To supply succulence by the use of root crops, however, has not been altogether practical in this country because farming conditions are vastly different from those in Europe, where lands are high-priced, labor plentiful and cheap and where corn is not so generally grown. To furnish succulence for rations, the European livestock man raises roots and feeds them abundantly. This is one of the chief factors that has enabled him to develop all breeds of livestock to such a high plane of perfection that the breeder of American livestock is compelled to bring across the ocean regular importations of fresh blood with which to improve the American animal.

So long as experience pointed to root crops as the sole source of succulence, winter rations in the northern part of the United States lacked entirely in this essential respect. Where lands are cheap and farming operations extensive, labor scarce and high-priced, such intensive agriculture as is necessary to grow root crops successfully is not favored. Therefore, in his efforts to develop livestock, the American breeder was greatly handicapped because, without some succulent food available for all the year, complete success cannot be obtained.

Only 39 years ago the silo was introduced into this country from France, where, in 1875, Auguste Goffart announced the successful results he had secured from experiments, covering several years, with preserving forage. The discovery was of so great import that the French government awarded him the Cross of the Legion of Honor.

After the silo was introduced into this country, it gradually became known that green corn could be preserved in a wholesale manner and provide succulence. All sorts of objections were lodged against its use. Condensors refused to buy milk from farms where silage was fed. Many doctors prescribed against the use of milk produced by silage-fed cows for babies and invalids. Farmers believed the acid in the silage would eat out the linings of the stomachs and intestines of their cows and make their teeth fall out. Some there were who thought it would cause tuberculosis, and others could not believe that green feed, put in any structure, could possibly fail to spoil.

All of these prejudices, along with others, had to be overcome and proved false so that a general use of the silo did not begin until 12 or 15 years ago. Since that time the silo has so demonstrated its value that it has become as prevalent as the haymow or the corncrib, with the result that today dairy cows in this country are yielding amounts of milk and butterfat greater than they are anywhere else in the world.

As is illustrated by plate No. 71, in comparison with plate No. 65, corn silage contains nearly twice as much dry matter as does the sugar beet. This is a point in favor of silage because it indicates greater feeding value than is to be found in roots, and the small amount of succulence replaced by dry matter is not sufficient to detract greatly from the factor of succulence, because in 100 pounds of mature silage there is found 73.7 pounds of moisture as compared with 83.6 pounds in sugar beets.

It is also interesting to compare plates No. 66 and No. 72. This comparison denotes clearly the advantage root crops have over silage. There are only 1.4 pounds of indigestible material in 100 pounds of sugar beets, while in 100 pounds of corn silage 7.8 pounds of indigestible material are found by chemical analysis. But, to offset this, there is nearly twice as much ash or mineral matter found in silage and the total digestible material is more than one-third greater, showing that, although corn silage is not so highly digestible as are roots, the combined digestible feeding value is greater.

By comparing plates No. 67 and No. 73, it is likewise found that corn silage is considerably more valuable than root crops in supplying digestible protein, carbohydrates and fat, the real feeding nutrients. Therefore, from the standpoint of chemical analysis alone, the feeder is justified in considering corn silage superior to sugar beets as a feed for dairy cows.

In physical character silage is more bulky than root crops, and this is another point much in its favor that should not be overlooked. This is one distinct improvement the use of corn silage has added

Fig. 1.

Fig. 2.

PLATE 71.

100 pounds mature corn silage—exact volume, 15x15x29.5 inches.

Figure 1, water, 73.7 pounds; figure 2, dry matter, 26.3 pounds.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

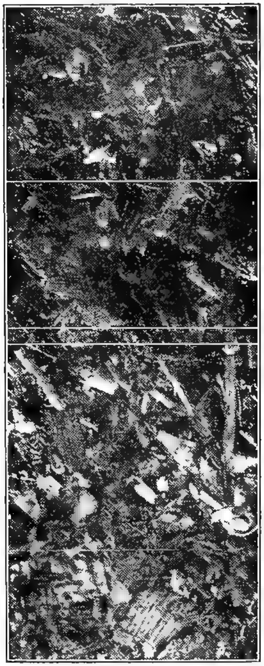


PLATE 72.

100 pounds mature corn silage—exact volume, 15x15x29.5 inches.

Figure 1, water, 73.7 pounds; figure 2, indigestible material, 7.8 pounds; figure 3, ash, 1.7 pounds; figure 4, digestible material, 16.8 pounds.

Roughage feeds being of a more bulky nature than concentrates necessitates the use of wider plates for illustrating the exact volume occupied by 100 pounds of feed. In considering the concentrated feed a receptacle 12 inches square was used with height varying according to the bulkiness of the feed. A receptacle 15 inches square will necessarily be used for a container for 100 pounds of roughages so that the length of the plates will be in keeping with the size of our pages.

The lightness of the dry matter in silage is well illustrated in this plate, where a comparison is made with water, the exact weight of which is definitely known. The 26.8 pounds of dry matter in 100 pounds of silage occupies 2¼ times as much space as 73.7 pounds of water is definitely known to occupy.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

PLATE 73.

100 pounds mature corn silage—exact volume, 15x15x29.5 inches.

Figure 1, water, 73.7 pounds; figure 2, indigestible material, 7.8 pounds; figure 3, ash, 1.7 pounds; figure 4, protein, 1.1 pounds; figure 5, carbohydrates, 15. pounds; figure 6, fat, .7 pounds.

to the system of feeding cows. It is now customary on most dairy farms to feed grain mixed with the silage, and by so doing the entire ration is rendered bulky and succulent to the extent that it digests more readily and efficiently than though the concentrated foods were fed alone.

The advantage of this system is well illustrated by an experiment conducted at the agricultural experiment station of Illinois, where one lot of steer calves was fed rations consisting of corn silage, oats and hay, and another lot shock corn, oats and hay. The average number of pounds meat made per acre when silage was fed with oats and hay was 385.35; when shock corn was fed with oats and hay, the average number of pounds of meat made per acre was 337.91—a difference of 47.5 pounds per acre in favor of a system of silage feeding.

Pigs were permitted to follow both lots of calves. Where the steers were fed silage, 97.69 per cent of the meat produced was beef and 2.31 per cent was pork. Where the shock corn was fed, 84.22 per cent of the meat produced was beef and 15.78 per cent was pork.

It is clearly shown by this test that where silage was fed a much larger percentage of the feed was digested by the steers, for the pigs following this lot of calves made a much smaller gain than those following the steers fed shock corn. This is of special importance to the feeder of dairy cows, because he cannot employ the service of pigs to save undigested portions of the feed excreted by the cow in the same manner as is possible for the feeder of beef cattle; and, even though he could, it is more advisable for him to so prepare the feed of the cow that she can digest the largest possible percentage of it, because her services are more valuable for producing milk and butterfat than for preparing feed for pigs.

In addition to being a most excellent source of succulence and bulk, corn silage has proved from practical experience to be one of the most efficient foods for stimulating large and economical milk and butterfat production. The excellent results secured by the practical feeder have been warranted by all experiments that have been performed for determining the real food value of silage. C. G. Williams, at the Ohio station, conducted an experiment to determine the value of silage as a substitute for a portion of grain ration fed to dairy cows. One lot of cows was fed an average daily ration of 58 pounds of silage, 6.8 pounds of mixed hay, 2 pounds oil meal and 2 pounds of bran. Another lot was fed 4.7 pounds of corn stover, 6.4 pounds of mixed hay, 2.5 pounds of oil meal, 5 pounds of corn meal and 6 pounds of bran. Both lots received from their rations practically the same total amount of dry matter, protein, carbohydrates and fat. The silage used in the test was a mixture of

one ton of soy beans and cowpeas to two and one-half tons of silage corn. There were nearly twice as many soy beans in the mixture as cowpeas.

In one ration over 50 per cent of the dry matter was derived from silage and less than 18 per cent was derived from grain. In the other ration, 57 per cent of the dry matter was derived from grain, no silage being fed. Ten cows representing five different breeds were fed this ration from two to four months, five cows taking the test the full four months.

The cows fed the silage ration produced 96.7 pounds of milk and 5.08 pounds of butterfat per 100 pounds of dry matter.

The cows fed the grain ration produced 81.3 pounds of milk and 3.9 pounds of butterfat per 100 pounds of dry matter.

The cost of feed per 100 pounds of milk was 68.7c with the silage ration and $1.055 with the grain ration. The cost of feed per pound of butterfat was 13.1c with the silage ration and 22.1c with the grain ration.

The average net profit per cow per month (over cost of feed) was $5.864 with the silage ration and $2.465 with the grain ration.

It was also noted, by averaging the daily production of the cows for the time they were on test and comparing this with their average daily production for the month previous to the beginning of the experiment, that the silage-fed cows shrank only 2.84 per cent in milk and increased 1.89 per cent in butterfat production. The grain-fed cows shrank 9.11 per cent in milk and 14.18 per cent in butterfat production.

Commenting on the results of the experiment, Williams concludes:

"The facts herein reported seem to justify the conclusion that silage can be made to take the place of a considerable portion of the grain ration. It is believed that by growing more of the feeds rich in protein—clover, alfalfa, soy beans, cowpeas, field peas, vetches—and ensiloing them or feeding them as hay, it will be possible to further reduce the amount of grain fed."

Silage can not be used as a sole ration. It is so bulky and contains so much moisture and so small a percentage of protein that to attempt securing profitable milk production from it, without supplementing it with leguminous hays and concentrated feeds, would be unreasonable; and practical experience indicates that it is impossible to secure satisfactory results from silage alone. Used, however, as a source of bulk, succulence and carbohydrates, in conjunction with foods that furnish protein and dry matter, no feed is superior to it.

There is a general belief that, even though silage is fed in abundance, greater production can be stimulated by adding roots to the ration. This method is largely practiced by feeders who are striving to make large records with cows, the cost of milk production being of secondary importance. There is no doubt that root crops used in this manner serve to increase the yield of milk and thereby the production of butterfat. Not only are additional food nutrients, succulence, palatability and variety added to the ration, but it must be conceded that roots have a very beneficial effect upon the general health and digestive capacity of the cow. When a cow is being worked to the limit of her ability, any food that will serve these joint purposes is advisable to use. But under ordinary conditions, where profit from milk production is even a more important factor than extreme greatness of yield, the addition of roots to the ration enough increase the production with sufficient profit to pay for the roots and the extra labor of feeding them. This illustrates in a forceful way the value of silage as a source of succulence.

There are instances when, for economical results, silage can be over fed. This condition seldom, if ever, prevails in the corn belt, as the stalks and leaves of the plant would be largely wasted if not made into silage, and where leguminous hays are, as a rule, scarce and expensive. But, in those sections where clover, alfalfa, soy beans, cowpeas, vetches or field peas are raised so abundantly and corn is raised with difficulty and at great expense, feeding nutrients can be secured more cheaply from the leguminous hays than from silage. Under such conditions economy calls for corn silage to be used in limited amounts for supplying succulence, bulk, variety and palatability. For these purposes, 10, 15 or 20 pounds of silage daily will serve the purposes for which it is best adapted, leaving the cow to secure the remaining nutriment needed for her maintenance and milk production from cheap protein hays supplemented with grain feeds. This indicates that the economy of a food depends not only upon its value and cost, but also upon the value and cost of other foods available for use either in substitution of or to be fed with the food in question.

An objection lodged against silage is that it contains so much acid it is harmful to the animals eating it regularly. There is no foundation for this opinion. Experience with silage has now existed over a sufficient period of years so that many very old cows can be found that have eaten silage regularly since calfhood without any serious effects. Contrary to the theoretical idea, the consensus of evidence points to the fact that healthfulness has been increased by the silage.

Commenting upon this subject, Esten and Mason, of the Storrs Agricultural Experiment Station of Connecticut, after an extensive investigation of silage fermentation, report: "The amount of acid consumed by the cow is quite startling. Suppose a cow is fed 40 pounds of silage in a day. In this silage there is about 10 ounces of pure acid which would be equivalent to the cow drinking seven quarts of vinegar a day. The equivalent for a man would be three pints of vinegar a day. These amounts of vinegar would certainly be damaging in either case. But since acetic acid is much less in amount than a favorable lactic acid, its presence does not seem to be harmful. The lactic acid is very beneficial as an appetizer and as a tonic to digestion. It also inhibits the growth of the undesirable bacteria in the elementary canal, alleged to prevent in man that serious disorder, auto-intoxication, which is the forerunner of a whole train of ailments attacking the animal organisms such as cold, headache, rheumatism, gout, and so forth."

It has also been quite conclusively proven that silage, judiciously fed, does not affect adversely the milk produced. Condensors that formerly refused milk from farms where silage was fed now advocate the use of silos. It is true that where cows are overfed on silage, and uneaten portions are permitted to remain in the feed boxes and about the barn to putrefy, unfavorable odors are generated which permeate the air. Where such a condition exists, milk absorbs these odors and becomes undesirable. This is not a fault of the silage, however, but a fault of the system employed in its use and reflects discredit upon the dairyman rather than upon the silage.

To determine the actual effects of silage upon the flavor of milk, several experiments have been performed. At the Oregon Experiment Station A. L. Knisely found that cows fed on silage produced milk with a different odor from that produced by cows fed on hay, although the odor was in no way disagreeable.

At the Wisconsin station King found that when silage was fed a short time before milking a sweetish odor was imparted to the milk, but when fed just after milking the fact that silage had been fed could not be detected even by experts.

At the Illinois Experiment Station, Professor Fraser divided the college dairy herd into two lots. To one of these lots 40 pounds of corn silage was fed daily to each cow and the other lot was fed only clover, hay and grain. The milk from both lots was handled in exactly the same manner, and samples from each lot were submitted to 372 persons for an opinion as to its comparative flavor and for determination of any objectionable taste or odor that might be present. As a result 60 per cent of those making the trial were in

favor of the silage milk, 25 per cent in favor of that produced from hay and grain, while 11 per cent of those making the examination could detect no difference on which to base a choice. The peculiarity of this experiment was that the percentage in favor of the silage milk was much higher when the silage was fed at the time of milking than when it was fed an hour before or an hour after milking.

On this subject, Professor Plumb, of the Ohio State University, comments as follows:

"It is now generally recognized that, with the modern methods of using silage and the proper precautions to prevent the milk after it has been drawn from the cow being tainted with the objectionable odor of badly fermented silage, the material may be freely used without danger of injury to the quality of dairy products."

There is a widespread prejudice against feeding silage to herd bulls and young calves. It is based on the belief that silage fed to bulls interferes with their fecundity and when fed to calves causes scours. While overfeeding likely substantiates the belief a moderate use of silage is advisable for furnishing succulence to the rations of both of these classes of animals. It should be used, however, as a source of succulence rather than of food nutrients, and 15 or 20 pounds daily should be the maximum amount given the herd sire. Young calves should receive only small amounts fed with their grain rations to the extent of giving bulk and adding succulence. Where fed thus judiciously no ill results will follow, and the health of the animals will be bettered rather than injured.

As an economic factor the silo is of especial value. The stalk and leaves of the corn plant represent 40 per cent of the feeding nutriments. Where the silo is used they are completely saved: otherwise they are left in the field, some to be cut and shocked for feeding purposes, but mostly to be left standing for pasturing, for the nutrients to be washed away by the rains, for many of the leaves to be blown away and for the stalks to be cut, burned or plowed under in the spring.

With the annual production of ears valued in round numbers at $2,673,000,000, without silos there would annually be wasted a large percentage of the corn stalks and leaves, the nutriment value of which equals more than $1,500,000,000. Oftentimes—in years gone by—while this great wealth of valuable food was locked up in snow-bound fields, good cattle without available food starved in barns, sheds and yards and their owners were compelled to send them to market to prevent complete loss. No greater extravagance

was ever practiced by intelligent, thoughtful people in times of peaceful occupation.

When it is conceded that silage is essential to successful feeding operations in winter, then it must be admitted that in most sections the summer silo is quite as important as is the winter silo. Hardly a summer passes that a severe drouth is not experienced. Pastures dry up and grasses fail to grow. It is not customary on a large percentage of farms to feed cows when they are on pasture and the consequence is that, suffering from heat and flies, they fail to secure the food necessary for maintaining their bodies and persistently producing the amount of milk to which they are accustomed. The milk flow declines, cows become poor and emaciated and profits in the dairy are turned to losses. When this condition obtains, even though rains may come to revive the pasture and cows may retain their former condition of strength and flesh, they do not return to their previous flow of milk. They may increase slightly, but never—until they freshen again—will they produce as largely as before they declined in milk flow on account of food shortage.

Thoughtful dairymen in all sections of the country now realize that in order to maintain large and steady milk flow they must provide against summer drouths. It is true that this can be done by summer soiling or raising of green feeds with which to supplement pastures. In the absence of the silo this method is advisable.

Commenting on the value of soiling crops and silage for dairy cows in summer, Woll, Humphrey and Oosterhius of Wisconsin, write as follows:

"That corn silage can be used to greater advantage than soiling crops in supplementing poor pastures and in keeping up a uniform and economical flow of milk has been demonstrated for three successive summers in feeding the university dairy herd. By the use of silage in summer the cows will be in better condition to enter the fall and winter, and the annual profit for the year will be increased."

The records of milk production for the two groups differed very little. For the three years the cows fed soiling crops produced 195.7 pounds more milk than the silage-fed cows, but 40 pounds more solids and 35.84 pounds more butterfat were produced by the silage-fed cows. The silage-fed group received 1,740 pounds more dry matter than did the soiling-crop-fed cows, but the soiling-crop cows consumed 420 pounds more protein during the trial than did the silage-fed cows.

Green corn is more commonly used for corn silage, and, because it is generally grown and most difficult to store in forms other than as silage, it is most to be recommended for silage purposes. More than this, the character of the plant is such that the very best silage is made from it. Reference is often made to making silage from clover, alfalfa, soy beans, cowpeas, etc. This is advisable only when corn is not available or when it is impossible, because of weather conditions, to save these crops in the form of hay. Ensiloed by themselves, they do not make as acceptable silage as corn. One distinct reason why this is true is cited by Esten and Mason, of the Storrs Agricultural Experiment Station, as follows:

"From a theoretical standpoint, if mixtures of some legume with corn could be siloed it would secure a complete balanced food. Unfortunately, the best legumes for this purpose are the clovers, which are ready for cutting in June. Only a second growth of clover could be siloed with corn in September. There are, however, two legumes which grow very well in Connecticut, cowpeas and soy beans, and these crops are ready to harvest by the time corn is ready to be cut. A mixture of three parts corn and two of cowpeas or soy beans makes a very good combination. The advantage of mixing these is that the corn has the sugar which, turned into acids, will preserve both the corn and legume at the same time. The result of siloing legumes alone is not satisfactory. The legumes, not having much sugar, do not afford the production of sufficient acid to prevent the fermentation of the high protein content of the legume. The protein is broken down into strong-smelling substances which are the result of incipient decay. It is likely to injure the legume as a food and to affect the quality of the milk in taste and smell."

One of the best methods of employing legumes for mixing with corn in the silo is to plant them together. It is now possible to secure attachments for corn planters which will enable the seeding of soy bean or cowpea seed in the hill with the corn. By selecting a variety of either cowpeas or soy beans that will mature at the same time corn matures, one of these legumes can be checked in the hill with the corn and a double crop produced which, when ensiloed at the proper stage of maturity, will make a very excellent quality of silage. There are two reasons why this method is preferable to growing the corn and the legumes separately. In the first place, a larger tonnage of silage can be secured per acre, and, secondly, both the corn and the legumes are cut at one operation and handled with one set of machinery.

To illustrate the comparative feeding value of the various varieties of silage, of which it should be remembered corn is the standard, the accompanying table from Henry's "Feeds and Feeding," shows the dry matter and digestible feeding nutrients:

	Total dry matter in 100 pounds Feeding stuff	Digestible nutrients in 100 pounds			
		Crude protein pounds	Carbohydrates pounds	Fat pounds	Total pounds
Corn, well matured, recent analyses	26.3	1.1	15.0	0.7	17.7
Corn, immature	21.0	1.0	11.4	0.4	13.3
Corn, from frosted corn	25.3	1.2	13.7	0.6	16.3
Corn, from field-cured stover	19.6	0.5	9.9	0.4	11.3
Kafir	30.8	0.8	15.3	.6	17.5
Sorghum	22.8	0.6	11.6	.5	13.3
Sugar-cane tops	23.5	0.5	12.2	.2	13.1
Alfalfa	24.6	1.2	7.8	.6	10.4
Apple pomace	20.6	0.9	15	.6	17.3
Barley	25	2	12	.8	15.8
Clover	27.8	1.3	9.5	.5	11.9
Corn and clover	28.6	2.1	15.9	.7	19.6
Corn and rye	19.4	1.1	10	1.0	13.3
Corn and soy bean	24.7	1.6	13.8	.8	17.2
Cowpea	22	1.8	10.1	.6	13.3
Cowpea and soy bean	28.5	1.9	13.2	.7	16.7
Field pea	27.9	2.8	13.1	.9	17.9
Millet	31.6	1.6	15.3	.8	18.7
Millet, barnyard, and soy bean	21	1.6	9.2	.7	12.4
Oat	28.3	1.5	13.8	.9	17.3
Oat and pea	27.5	2.8	12.6	1	17.6
Pea-cannery refuse	23.2	1.6	11.6	.8	15
Sorghum and cowpea	32.3	0.9	16.6	.6	18.9
Soy bean	27.1	2.6	11	.7	15.2
Sugar beet leaves	23	2.1	10	.4	13
Sugar beet pulp	10	0.8	6.5	.3	8
Vetch	30.1	2	15.2	.8	19
Wet brewers' grain	29.8	5	11.1	1.9	20.6

CHAPTER XV.

CORN STOVER

Even in sections where silos are most plentiful, it is not usual that the entire corn crop can be ensiloed.

It has been demonstrated that where hogs are fed a portion of the crop can most profitably be hogged down.

Where beef cattle are fed the fodder—which is the entire plant, consisting of stalks, leaves and ears—can be hauled to racks and fed whole because those kernels of corn which are not digested by the steers are recovered by hogs following. Experiments have proved that, even though the waste of stover is extensive when the fodder is fed in this manner, it is not great enough to pay for the labor incurred in shredding the fodder and feeding the corn separately. And, because steers are fed in open lots, the corn stalks that are left can be handled with a degree of convenience. Some corn fodder can be used in this same manner for young things and dry cows that are being roughed through the winter cheaply, but it is not the rule that corn fodder can be most advantageously fed in this manner on dairy farms.

The approved methods of feeding dairy cows demand that the cows be stabled and that their grain be ground to encourage production that is at once large and economical. This practically eliminates the use of whole corn fodder as an advisable feed for them and, likewise, it prohibits a consideration of the all too prevalent method of shucking the corn and leaving the stalks and leaves standing in the field for cows to browse, regardless of climatic conditions.

Therefore, but one advisable system remains. When the silos have been filled and a portion of the field given over to the hogs to convert into pork without the aid of man, all corn that remains should be cut promptly, shocked and left in the field only long enough to cure well. As soon as it is dry enough so the corn will not spoil in the crib, nor the stover mold in the barn or stack, it should be shredded. There is much value in corn stover if it is shredded in the late fall before it becomes frozen and covered with snow, provided it is protected from the elements which leach from unprotected shocks much of the most valuable nutriment, and the most palatable and most nutritious portions, the leaves, are blown away.

A completely equipped dairy farm should have a roughage shed large enough to house the shredded fodder as well as the hay. Where both cannot be sheltered under roof, it may be more advisable to stack the hay and shelter the stover, because hay can be stacked so it will suffer much less from wind, rain and snow. Where shredded corn stover is carefully preserved, it is distinctly valuable wherever cows are kept. Nothing is superior to it for bedding purposes. Its capacity to absorb liquid surpasses any kind of straw. It is comparatively free from dust; it makes for the cow a comfortable bed; it keeps her clean, and, when—with the manure—it is returned to the field, it can be readily turned under to quickly rot or it can be used to excellent advantage for top-dressing purposes.

For bedding purposes alone it is worth in many sections from $6 to $8 per ton, and its fertilizing value when returned to the field amounts to $5.19 per ton, estimating nitrogen to be worth 20c per pound and phosphoric acid and potash each worth 5c per pound. This also is a value that is largely lost where stalks are left to stand in the field all winter.

But these are secondary values. Shredded corn fodder has real feeding value worthy of consideration where profit from producing milk and butterfat is the aim. For furnishing dry matter it is as useful as most of the carbonaceous hays. This is shown by plate No. 74, which represents 100 pounds of shredded fodder containing a medium content of moisture. Furthermore, supplying dry matter is one of its chief values, especially where silage is heavily fed, and this suggests an excellent method of using it. When cows have eaten to their satisfaction of silage and the mangers are filled with clean, bright, shredded stover, they go to work again picking out the choice morsels of palatable leaves, stray kernels of corn, and even the smaller pieces of stalk, eating them with avidity. This gives assurance that the daily ration furnishes the required amount of dry matter. If leguminous hays and much protein concentrates are fed with the silage and roots, the feeding of the stover further assures a properly balanced ration, for enough will be eaten to furnish carbohydrates where they are needed. As is shown by plate No. 76, corn stover is rich in this nutrient, although, as plate No. 75 explains, it contains much indigestible material and a comparatively large percentage of mineral matter. After the cows have picked out the best from the stover, what remains is not wasted, for, when it is placed under the cows, it serves as well for bedding as though it had not first been offered to them as a feed.

Where one does not have a silo, corn stover can be made to serve fairly well as a succulent food by moistening it thoroughly

Fig. 1.

Fig. 2

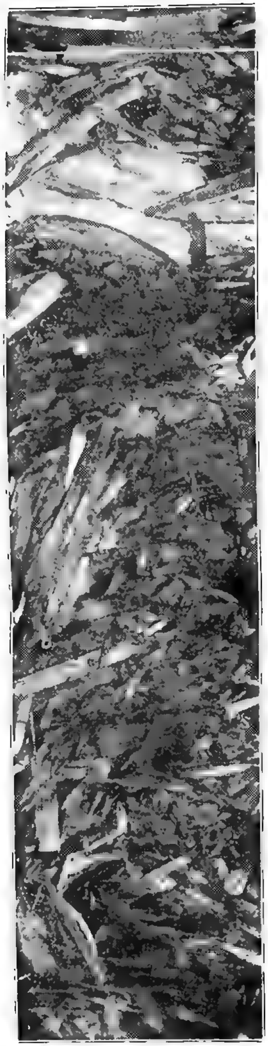


PLATE 74.
100 pounds corn stover—
exact volume, 15x15x47.2 inches.
Figure 1, water 19 pounds; figure 2, dry matter, 81 pounds.

Fig. 1.

Fig. 2

Fig. 3.

Fig. 4.

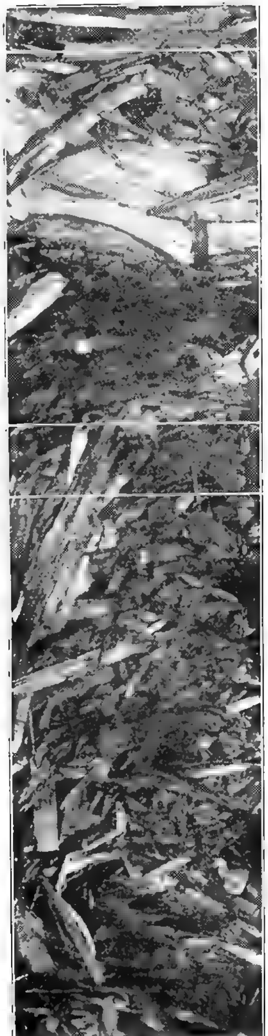


PLATE 75.
100 pounds corn stover—
exact volume, 15x15x47.2 inches.
Figure 1, water, 19 pounds; figure 2, indigestible material, 30.3 pounds; figure 3, ash, 5.5 pounds; figure 4, digestible material, 45.2 pounds.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5

Fig. 6.

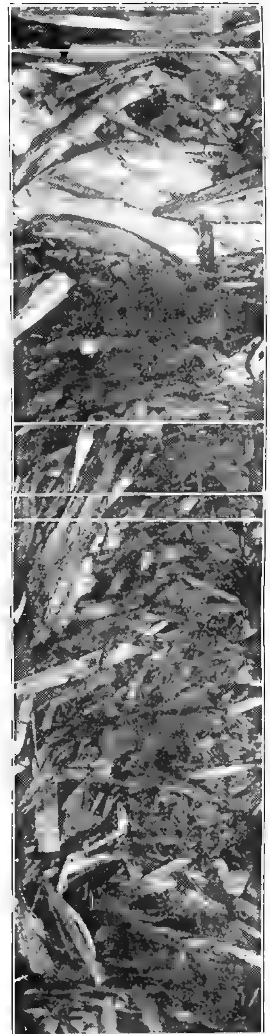


PLATE 76.
100 pounds corn stover -
exact volume, 15x15x47.2 inches.
Figure 1, water, 19 pounds; figure 2, indigestible material, 30.3 pounds; figure 3, ash, 5.5 pounds; figure 4, protein, 2.1 pounds; figure 5, carbohydrates, 42.4 pounds; figure 6, fat, .7 pound.

with hot water, mixing concentrates with it, covering the mass with sacking or blankets and leaving it to steam and soften for several hours.

Many years ago when "Tama Jim" Wilson, ex-secretary of agriculture, was director of the Iowa Experiment Station, he tested this method of using shredded fodder and found he was able to secure almost as great production of milk and butterfat as when silage was used for succulence, and the quality of butter produced was somewhat superior to that which was produced with the use of silage. This does not indicate, however, that cut or shredded corn fodder or stover should be used in preference to silage, because the cheapness with which silage is prepared recommends its use as the most convenient and economical system of utilizing the corn plant for dairy purposes.

When considered from its various standpoints, corn stover proves itself of great value; in fact, far too valuable to be wasted in the wholesale manner in which it is, representing, as an acre of it does, an amount of feeding nutriment at least equal to the grain which grew upon it. But when fed alone, because of the small amount of protein and the large amount of indigestible material it contains, animals can barely live upon it and cannot be expected to yield milk.

In this respect it resembles very closely timothy hay, and, according to Cyril G. Hopkins, who conducted experiments at the University of Illinois to determine the composition and digestibility of corn stover, the eatable portion of it has a nutrient value fully equal to that of timothy hay.

Large is the value of corn stover when used for what it is worth and as a supplement for adding dry matter, variety and carbohydrates to rations lacking in these respects. As short-sighted is the one who, having acres of corn stalks going to waste, ignores their worth, as is the one who over-estimates the value of corn stover and expects his animals to thrive upon it as a sole ration without feeding with it foods which furnish succulence and additional digestible nutrients.

CHAPTER XVI.

TIMOTHY HAY

A discussion of timothy hay following that of shredded corn stover might be brought to an abrupt close and yet portray the actual value of this most generally used hay by stating that for feeding purposes it is a trifle better than shredded corn stover, but much less valuable for bedding, and that a ton of it contains just a trifle more fertilizing nutrients than a ton of corn stover.

The comparison of the content of moisture, ash, indigestible material and digestible feeding nutrients of timothy hay with corn stover will be readily appreciated by the following table:

100 pounds	Moisture, pounds	Dry matter pounds	Indigestible material, pounds	Ash, pounds	Digestible nutrients in 100 pounds		
					Protein, pounds	Carbo-hydrates, pounds	Fat, pounds
Corn stover	19.0	81	30.3	5.5	2.1	42.4	.7
Timothy hay	11.6	88.4	36.5	4.9	3.0	42.8	1.2

To study this comparison is to recognize that, where valuable land is devoted to raising timothy, an extravagant mistake is being made if corn stover can be secured at the usual low cost for feeding purposes. The very fact that a ton of timothy hay contains 200 pounds more indigestible material and only 18 pounds more protein, 8 pounds more carbohydrates and 10 pounds more fat in a digestible form than the stover shows that the feeding value of timothy is generally overestimated.

One lecturer has said that the only reason cows do not starve to death when compelled to live on timothy hay alone is because they cannot eat enough of it. This is a forceful expression, yet it is true that, because of the low amount of protein and the great amount of indigestible material contained in timothy hay, it is almost impossible for a cow to eat enough of it daily to maintain her own body, much less to be expected to produce milk either largely or profitably.

Although timothy hay contains a very small amount more protein and fat than corn stover, the two seeming advantages it has are that it is more palatable and its physical characteristics are such that it will be eaten with less waste. Yet, where corn stover is properly harvested and preserved, it proves almost as palatable, and that which

is assumed to be waste from a feeding standpoint is gain in value for bedding. In many sections the feeding value of both of these roughages, when compared with leguminous hays, is so small that the value of the wasted portions of the stover is greater when used as bedding than the timothy hay is as a foodstuff.

Timothy hay is recognized as an excellent roughage for horses because it is palatable to them and is more free from dust than are leguminous hays. For this reason it always commands a good price on the market. Therefore, it is wisdom and a demonstration of good judgment for the dairyman to sell his timothy and shred corn stover, carefully preserving it for use instead of higher priced timothy hay.

I can realize that there are circumstances that would lead a dairy farmer to raise timothy hay. Perhaps there is justification in seeding it with clover so that if a stand of this more useful hay is not secured, or if it freezes out, the ground that was seeded will not stand idle. Perhaps there are certain sections, and some farms in other sections, where legumes cannot be grown successfully. Surely it is true that timothy can be raised and harvested with ease and certainty in many parts of the United States. But, with an ever-present market for timothy hay, with corn stalks nearly everywhere going to waste, and hays made from legumes everywhere available at prices such that more profitable milk production may be secured by selling the timothy and investing the proceeds from it in shredding the corn stover, I am unable to fathom the thoughts of a man who will feed timothy hay for large and economical milk production.

To determine in an authentic manner the exact value of timothy hay as a fed for dairy cows in comparison with alfalfa hay, Wilbur J. Fraser and C. C. Hayden of the Illinois University, conducted an exhaustive experiment in which 16 cows were divided into two lots of eight each, and, after a preliminary feeding period of three weeks, the following 18 weeks were divided into two feeding periods of nine weeks each, and this was followed by a subsequent period of four weeks. The feed was weighed to each lot but not to each individual cow. Throughout the entire demonstration the basic ration consisted of a grain mixture of two and one-half pounds of corn meal to one pound of wheat bran and shredded corn stover. The ration is shown in tabulated form below:

Average Ration

Lot 1		Lot 2	
First period—		First period—	
Mixed grain	13 pounds	Mixed grain	13 pounds
Corn stover	10 pounds	Corn stover	10 pounds
Timothy hay	10 pounds	Alfalfa hay	10 pounds
Nutritive ratio—1 :10.2.		Nutritive ratio—1 :6.6.	
Second period—		Second period—	
Mixed grain	12 pounds	Mixed grain	12 pounds
Corn stover	10 pounds	Corn stover	10 pounds
Alfalfa hay	10 pounds	Timothy hay	10 pounds
Nutritive ratio—1 :6.6.		Nutritive ratio—1 :10.2.	

When the experiment was concluded it was possible to tabulate the following table.

In explanation of this table the experimenters call attention to the fact that the figures can be applied only when the alfalfa and timothy hay are fed with the feeds used in the test, or with other similar feeds. However, with this in mind, the reader cannot help but be impressed with the utter folly of depending upon timothy hay for feeding dairy cows when it is possible to secure alfalfa hay either by raising or purchasing it on the market. The fact is thoroughly demonstrated that timothy hay can be sold and alfalfa hay purchased at twice the price per ton and larger and more economical milk production results.

The knowledge of the extremely greater value of an acre of ground devoted to the raising of alfalfa hay instead of timothy hay

Price of milk per 100 pounds	Value of alfalfa per ton, above timothy	Value of alfalfa, per acre, above timothy, when timothy is worth $10 per ton. (Alfalfa four tons per acre; timothy one and one-half tons per acre.)
$1.00	$ 8.36	$58.44
1.10	9.19	61.76
1.20	10.03	65.12
1.30	10.86	68.44
1.40	11.70	71.80
1.50	12.54	75.16
1.60	13.38	78.52
1.70	14.21	81.84
1.80	15.06	85.24
1.90	15.88	88.52
2.00	16.72	91.88

must make impressive the fact that even though it may seem difficult and expensive to secure and maintain a stand of alfalfa, it is worth the study, the effort and the expense which is necessary to convert the timothy field into one growing legumes.

Commenting upon the condition of the cows used in the above test, Fraser and Hayden report as follows:

"Besides the greater returns in milk, the condition of the cows count for much. At the end of each period, the cows which were fed alfalfa hay were in much better condition than those fed timothy. The timothy, although of good quality, was not palatable, and the cows receiving it lost in flesh, their hair was rough, and they were in poor condition, generally. A number of them were more or less 'off feed' at different times. Such was not the case with the same cows while being fed alfalfa. They had better appetites and ate their corn stover more readily than when receiving timothy hay. If the effect is so great in so short a time, it is easy to see why many of the dairy cows in Illinois come out of the winter in poor condition and have a small milk account to their credit."

CHAPTER XVII.

STRAW

There was a time when straw resulting from threshing various grains was considered valuable for feeding purposes. Young stock was expected to winter in the stalk field and the straw stack as a source of variety. Animals in good condition from their summer feeding on luxuriant pastures, as they existed in those days, had stored up in their bodies surplus fat so that, even under these conditions, they managed to live until grass came again, but every day they were subjected to this sort of feed and management they decreased in weight, flesh and condition.

Experience and experiments have so fully shown the folly of such methods of feeding that seldom indeed is a farmer to be found who believes that straw possesses any great virtue as a source of food nutriment. Yet, under certain conditions, straw is palatable and useful.

As shown by the following table, it contains as much dry matter as timothy hay and corn stover, equally as much digestible carbohydrates and an amount of mineral matter equalling that possessed in stover and greater than timothy hay. As a matter of fact, a careful comparison of oat straw with timothy hay leads to the conclusion that, like shredded corn stover, it may be used in place of timothy hay for supplementing other foodstuffs.

100 pounds	Moisture, pounds	Dry matter pounds	Indigestible material, pounds	Ash, pounds	Digestible nutrients in 100 pounds		
					Protein, pounds	Carbo-hydrates, pounds	Fat, pounds
Corn stover	19.0	81.0	30.3	5.5	2.1	42.4	.7
Timothy hay	11.6	88.4	36.5	4.9	3.0	42.8	1.2
Oat straw	11.5	88.5	38.6	5.4	1.0	42.6	.9

Not alone is it necessary to consider the value of oat straw from the chemist's standpoint, for observation of a herd of cows presumably well fed shows that straw is appreciated by them. Who has not seen a cow being heavily fed, on alfalfa hay, silage and grain, turn in her stall, pick up bits of straw and eat them with avidity, when she is freshly bedded?

Very often silage-fed cows fail to secure from the remainder of their ration enough dry matter. If they are fed narrow grain rations and alfalfa or clover hay to furnish protein, there is a likelihood that carbohydrates are needed to balance the ration. For supplying both dry matter and carbohydrates, straw is useful, and, when it is used for bedding, it may in addition be used also as a factor of safety to make sure that cows receive enough dry matter and carbonaceous material to maintain their bodies and to provide that from which to make milk and butterfat.

An excellent way to use it for feeding purposes is to place that amount which would be used for bedding in the cow's manger, leaving it there long enough for her to pick it over, securing from it chaff, occasional kernels of grain and the other palatable portions she may find. It will be a surprise to most feeders to note the great amount that will be eaten. The milk scales will also vouch for the fact that the cow's time occupied in eating and digesting straw is not entirely wasted.

In European countries where farmers cannot afford to practice the extravagance so prevalent in this country, straw is very largely used in compounding rations. After running it through a cutting machine and chopping it into short lengths, it is mixed with roots and grains, thus providing a ration that is palatable, well balanced and sufficient for large, yet inexpensive production. The animal not only secures from the straw what food nutrients it contains, but, because of the bulk given the ration, digestion is aided and the animal secures greater value from the other foods mixed with it.

In this country where other roughages are available in so great abundance and labor that would be incurred in cutting and mixing the straw with rations is so expensive, there is much doubt about this method being of sufficient importance for recommendation and, no doubt, the plan of offering the whole straw to the cows to pick over before using it for bedding is the most advisable one under the majority of conditions. That every dairyman can well afford to use liberally of straw in this manner is certain, because, in addition to the feeding and bedding value of it, each ton that is returned to the field takes with it $2.68 worth of nitrogen, phosphoric acid and potash, the essential fertilizing constituents so necessary for maintaining and building greater soil fertility.

Other straws, such as those derived from threshing millet, barley, buckwheat, rye, rice and wheat, are less valuable than is oat straw for feeding purposes because they are less palatable and carry less feeding nutriment. Nevertheless, it is advisable to use them in the same manner, for certain it is that no harm will come from their

use, and the method is such that what little feeding value is secured from them is in addition to that which results from their use as bedding and being returned to the field in the best possible manner for fertilizing purposes.

In those sections where alfalfa, clover, beans, peas, soy beans and cowpeas are threshed for seed purposes, a straw results which is more valuable than oat straw for feeding purposes. From three to four times as much protein per ton of straw is secured, with the amount of digestible carbohydrates and fat practically equal. Because of the larger proportion of digestible protein, these leguminous straws are such that they will just about provide a maintenance ration. For this reason they are valuable as supplementary feeds to be used in conjunction with rations conducive to milk production. Being coarser in character, with stems that are hard and brittle, they are not altogether palatable, neither do they make as good bedding as does oat straw. Under conditions where their use is an important factor in decreasing the cost of feeding dairy animals, they can be made most useful by cutting them into quarter-inch lengths, moistening them just enough to soften the stems and cause them to adhere to particles of other feeds. Used in this manner it will be found they have been rendered sufficiently palatable so that animals will eat them with avidity and increase in production according to the feeding nutrients contained in the straw.

Naturally, because of the larger content of protein possessed by leguminous straws, their nitrogen-furnishing power is greater than is that of the carbonaceous straws. Because of this more fertility is returned to the field when they are used for feeding and bedding purposes.

The point I would bring out in discussing corn stover and the various kinds of straw is not that they are extremely valuable for feeding purposes. On the other hand, the use of either corn stover or any kind of straw as a sole ration for dairy animals is to be discouraged. The real importance of the discussion is to illustrate the fact that each compares very favorably with timothy hay and, like this roughage, which occupies so many acres of valuable land, they may be used to advantage for supplementing other rations and adding to the variety, dry matter and carbohydrates of any ration that may be lacking in these respects.

With a knowledge that these by-products of grain raising can be used in substitution for timothy hay, it will enable the feeder to decrease the cost of his ration by selling his timothy or devoting the acres that grow it to other purposes.

CHAPTER XVIII.

OTHER CARBONACEOUS ROUGHAGES

So similar in feeding value are the various roughages rich in carbohydrates and poor in protein that, to a large degree, what has been written regarding corn stover, timothy hay and straw may be said to apply to the feeding value of all.

Soil, climatic conditions and the availability of protein feeds necessitate raising certain plants. Because thereof roughages that are grown in abundance in one section, and useful for feeding purposes there, are neither available nor advisable for feeding purposes in other sections. The less bulky and more expensive concentrates can be shipped from one section to another and this, to some extent, is true of the more valuable protein hays and roughages. Because in every section one or more grasses of the carbonaceous type can be raised it is seldom advisable to ship them long distances.

The value of any feed is two-fold. Primarily it is valuable to the extent that it furnishes the animal with digestible food nutrients. If, however, practically all grains and grasses grown in a vicinity furnish the same nutrients to the exclusion of other essential nutrients, it is evident that a feed which will supply that which is generally lacking for the purpose of balancing rations is doubly valuable. Therefore, the secondary value of a food is its usefulness in providing that of which there is a scarcity in those feeds most easily and prevalently grown. It cannot be said of either protein or carbohydrates that one is more valuable than the other for feeding dairy cows. Both are essential, and a ration ever so rich in one, but lacking in the other, is faulty. For this reason a carbonaceous roughage that would be of limited worth in the corn belt, where corn is so abundantly grown, would be of large value in the south where cottonseed meal, soy beans and cowpeas are so plentiful, or in the west where alfalfa grows so bountifully. It is for this reason that the feeder should have an accurate knowledge of the roughages and their characteristics that he may grow those that will help him to solve his feeding problems, as well as those best adapted to climatic and soil conditions.

Prairie Hay

In many states, especially in the north, much prairie hay still grows, quite as it did half a century ago. In some instances, speculators secured large acreages in early days, holding them for the increase in the value of the land. They have refused to permit the

turning of the virgin sod. Each year a crop of hay is sold standing at a very low price to farmers living near enough to harvest it. In other instances, where as yet land has not been tiled sufficiently for crop-growing purposes, prairie hay is still allowed to grow. Where these conditions exist, a very useful carbonaceous hay can be secured at a low cost. Being prized more highly as a feed for horses, the rule is that it is advisable to sell prairie hay, investing the proceeds in a leguminous hay more suitable for milk production.

On the other hand, many dairymen have found prairie hay to be quite valuable for calf feeding purposes where youngsters are fed heavily on skim-milk and other protein foods. It proves to be an excellent filler, distending the barrels of calves, developing the digestive apparatus and having a tendency to decrease the liability of scours.

Chemists find prairie hay to be quite analogous to timothy hay in the content of digestible nutrients, and somewhat higher in mineral matter. Therefore, from the standpoint of practical feeding operations, it is safe to assume that prairie hay can be substituted for timothy with the expectation of securing equally good results.

Brome Grass

Another grass that makes a hay so similar to timothy that they may be considered practically equal, when used as a roughage for dairy cattle, is brome grass. As a rule this is used more as a pasture grass to be mixed with other grasses rather than grown by itself. It is especially valuable because it provides pasture early in the spring and late in the fall, also furnishing much pasturage in the summer if the season is favorable. It is palatable and produces largely. In parts of Kansas, Nebraska, Minnesota, the Dakotas, Canada and in the western states, where bluegrass and timothy do not thrive well, brome grass is becoming quite a popular pasture and meadow grass. It has a distinct value in the states where the securing of carbohydrate material to feed with alfalfa and other protein feeds is a problem.

Owing to the fact that it thrives better on sandy soil and seems peculiarly adapted to the climatic conditions of the sections where it is most largely grown, brome grass should receive consideration from dairymen in search of carbohydrate material for balancing rations. But, where carbohydrates are plentiful and protein scarce, brome grass, like timothy and prairie hay, should be considered a crop that should be sold and replaced with a roughage rich in protein.

Orchard Grass

A characteristic of orchard grass is it grows in large tufts, and for this reason it is seldom considered as a sole grass for meadows. It

withstands drouths and grows better on sandy soils than does timothy, so that, in sections where timothy does not grow well, orchard grass sown with other grasses is oftentimes used as a substitute. It may be considered almost equal to timothy in feeding value. It is thought to be more nutritious, but because it grows ranker and coarser it is not eaten so rapidly. This objection can be practically overcome by cutting it early or at the time it is just in blossom. Orchard grass is grown over so small an area that it does not demand general consideration as a roughage by the dairyman. Where it is grown and a carbohydrate roughage is necessary, it may be fed in substitution for other grasses that rank with timothy hay. Otherwise it should be used for pasturage or sold and replaced by a roughage more stimulating to milk production.

Red Top

In the eastern and southern states red top is very largely raised for hay. As a rule it is sown with timothy, but, being a longer lived crop, takes the meadow after the timothy has died out. Red top grows especially well in moist soils and is more advisable to use for rendering such parts of fields, meadows and pastures productive than for growing as a general crop. It is richer, slightly, in both protein and carbohydrates than timothy hay, but, generally speaking, it may be considered on the same basis in practical feeding operations, and may be substituted for timothy hay without expecting that cows will either increase or decrease in milk flow to any perceptible extent.

Other Low Protein Grasses

There are numerous other low protein grasses found in various sections of the country that dairymen may find available, such as Johnson grass and Bermuda grass, which are grown so extensively in the south; rye grasses, meadow fescue, wild oats grass, buffalo grass, grama grass, para grass and others. Where these grasses grow, seemingly, they must be utilized to best advantage for feeding cows. Like the other low-protein grasses, their value rests largely with the fact that they are palatable; they furnish digestible food nutrients—most largely carbohydrates—to a rather limited degree; they furnish dry matter, and the rule is that they may be advisedly used provided their cost does not exceed their real feeding value and provided they are supplemented with other roughage and concentrates that are sufficiently rich in protein to balance the ration and furnish that nutriment which is known to be necessary for animal maintenance and for supplying the nutrients present in the milk and butterfat which the cow is capable of producing. Used without consideration of these well established truths—and this, too, often occurs—these low protein feeds are accountable for low production. In other

words, feeders are inclined to depend too largely upon hay made from these grasses, not realizing the low feeding value of them. The safe rule to follow when any one or more of these grasses are used for hay, whether or not they are supplemented with corn silage, is to feed a very narrow ration of concentrates, one comparatively rich in digestible protein in proportion to the carbohydrates it contains.

Feeding Nutrients contained in Low-protein Grasses. From Henry & Morrison

				Digestible Nutrients		
Feeds	Pounds	Lbs. Dry Matter	Pounds Ash	Pounds Protein	Carbo-hydrates	Fat
Timothy hay	100	88.4	4.9	3.0	42.8	1.2
Kentucky Blue Grass hay	100	86.8	6.6	4.7	43.5	1.5
Brome Grass hay	100	91.5	7.7	5.0	44.2	0.9
Meadow Fescue hay	100	88.3	7.0	3.5	45.2	1.1
Gama Grass hay	100	88.2	6.2	3.4	40.5	0.8
Johnson Grass hay	100	89.9	7.5	2.9	45.0	1.0
Oat Grass hay	100	88.2	6.1	3.4	38.4	1.2
Prairie Grass hay	100	93.5	7.7	4.0	41.4	1.1
Orchard Grass hay	100	88.4	6.9	4.7	41.1	1.6
Red Top hay	100	90.2	6.8	4.6	45.9	1.2
Italian Rye Grass hay	100	88.6	7.5	3.9	40.7	1.0
Wheat Grass hay	100	92.7	6.9	4.0	48.5	0.8
Wild Oat Grass hay	100	92.1	6.4	3.8	42.8	1.4
Wild Rye Grass hay	100	89.2	7.3	4.0	47.3	1.1
Bermuda Grass hay	100	90.3	7.6	3.7	37.9	0.8
Buffalo Grass hay	100	93.0	11.5	3.8	43.9	0.8
Gama Grass hay	100	93.4	9.0	3.2	41.9	0.7
Para Grass hay	100	90.2	6.6	2.3	38.7	0.4

CHAPTER XIX.

SOILING CROPS

On every dairy farm soiling crops should be grown. Cows will produce large amounts of rich milk economically only when their environment is such that they are not only well fed but comfortable. In all sections of the country there is a season of the year when the heat is so severe and the flies so tormenting that, to be comfortable, cows must be protected by stabling. It has never been definitely proved that there is a possibility of increasing the percentage of butterfat in milk permanently and to a large degree by feeding, but all experience shows that comfort of the cow is conducive to a high test.

To be a source of profit, the cow must work a large percentage of her time, so that if stabled even in a cool barn and protected from the flies, she must have access to food. It being a season when she is accustomed to succulent foods, she will not respond so profitably to dry forage. If a large percentage of the nutrients necessary to stimulate her greatest milk flow are given her in the form of grain, the cost of milk is increased to a point where profits are uncertain.

Therefore, it becomes apparent that most excellent results demand succulent foods in addition to pasturage. True it is that heat and flies are not troublesome at night, and I frankly agree that cows should be permitted to graze when conditions are such that they find comfort in doing so. Another obstacle arises, however, in that in most sections there invariably comes a period of drouth some time during the summer months, when food is so scarce in the pastures that exercise is about all cows receive during their grazing hours. As a matter of fact, observation from traveling over all parts of the United States inclines me to believe that cows suffer more for want of food and lack of comfort in the summer than they do during the winter months. It has so long been the custom to raise and store feeds during the summer to be used in the winter that everywhere, when fall comes, granaries are full, hay is plentiful, and, of late, silos bulge. But, in years gone by, livestock were so few in number and land so plentiful, that, regardless of heat, flies and drouth, cows could find sufficient food and protection. Therefore, our fathers and grandfathers had no occasion to furnish their animals food other than pasturage during the summer months. The customs we have to follow do not recommend soiling. It is a fact that, not only pertaining to religious and political matters have many of us permitted others to do our thinking for us, but also in matters related to busi-

ness affairs. As a result, year after year, the production of dairy products, after the increase resulting from the coming of spring days and green, luxuriant grasses, shrinks far below winter yields.

But I need not dwell upon the advisability of summer soiling, either partially or in full, for there is no one who will not agree that under present-day conditions profits in summer time are absolutely dependent upon supplementing pastures.

Best for the purpose is corn silage. Were I compelled to sacrifice either my winter silo or the one which holds the summer succulents, I would part with the former. It is easier to provide suitable winter rations without silage than it is summer rations. A few advantages summer silage has over soiling crops are: 1. It is less expensive. 2. Its feeding value remains constant. 3. It is always ready and convenient to feed.

From the standpoint of cost, corn silage is less expensive than summer-grown soiling crops because, during the fall of the year when the silo filling crew is at work, the silage is all made at one time, making it less expensive than though daily throughout the summer a man and team are kept busy a portion of the time, gathering soiling crops and hauling them to the barn to be fed. Furthermore, silage is made from a practically mature crop, and, therefore, a greater tonnage of digestible feeding nutrients is secured from an acre, again lessening the cost.

The objection to summer soiling crops is not only that time and labor are required in preparing small plots of ground, seeding and harvesting the crops, but during the feeding season there occasionally come rains which render the field muddy, the forage wet, and splashed with mud particles which make the process of feeding disagreeable, and the food unpalatable. Again, as a particular plot of soiling crops approaches maturity, the feeding value changes from day to day because there is an increased percentage of dry matter and digestible nutrients in proportion to the water content. When the time comes to change to the next successive plot the animals are changed from a food that has nearly reached maturity to one that is quite immature, occasioning a radical deviation in the quality of food. In this respect corn silage has a distinct advantage in that it is of practically the same palatability and feeding value from top to bottom. Dairy cows by consuming the same number of pounds secure practically the same volume of dry matter and nutriment.

Even though it must be admitted that the thoughtful dairyman who looks for the greatest profit from his business must summer soil his cattle, there is a reasonable excuse for not doing so which is very often presented. Summer is a busy time, all hands are active in seed-

ing, growing and harvesting crops for winter, leaving not much available opportunity for growing and harvesting crops for soiling purposes.

There are many who determine that they will provide better food and comfort for their cows in summer, but when the time comes they find themselves so busy with other things and fail to do so. Herein lies the great value of the summer silo. When the silage is made in the fall, regardless of all seasonable conditions, it is ready to feed when the flies and the summer droughts come. It is certain to be available, regardless of weather conditions and regardless of how busy every one on the farm becomes in spring and summer. When the hot days come and the neighbor's cows stand in the adjoining pasture under the shade of a tree, or perhaps in the cool water fighting flies, decreasing day after day in their milk flow, it is surely gratifying to the breeder and dairyman, with a summer silo, as he feeds his cows twice daily to give them a mess of palatable, succulent, easily digested, green silage to see them respond with an increased milk flow that means much by way of profit for his thoughtfulness and intelligence. Furthermore, in case it so happens that, during any particular summer, pastures remain excellent throughout most of the season and flies are less pesky than is the rule so that cows need a less amount of soiling, or perhaps none during certain portions of the summer, it is possible to leave the silage for winter or for another summer. Once silage is properly placed within its receptacle, it is somewhat like certain other things, the older it gets the better it becomes. Therefore, the factor of waste is so small that it scarcely needs to be considered.

Summer silage is made in exactly the same manner as winter silage, the only difference being that the silo in which it is contained must be smaller. It is absolutely necessary to feed at least two inches off the top each day to eliminate trouble from mold due to hot weather. Therefore, and because it is supplemented by more or less grass, the summer silo should be only about two-thirds as great in diameter as the winter silo.

Where the summer silo is not available and on farms where the whole farm is devoted to the raising of feed for winter, making it impracticable to raise soiling crops, dried beet pulp is a most advisable food, but, because of the great demand for the limited supply, it is necessary to purchase it in the fall and store it for summer use. In localities accessible to beet sugar factories, that do not possess dryers, the wet beet pulp is highly appreciated by farmers, who haul it direct to their farms and feed it abundantly in bunks to their cows, in quite the same manner as the feeder of the corn belt feeds corn to his steers.

Where neither of these plans is possible nor advisable, then provision should be made to have green feed growing and ready to feed whenever summer conditions necessitate doing so.

Sweet clover and alfalfa are the first to recommend themselves because they are green and luxuriant early in the spring, and remain in that condition quite persistently throughout the summer and even into late fall. It is unfortunately true that only about one man in each community believes alfalfa will grow in his particular section and who succeeds in growing it. Likewise it is equally as unfortunately true that in every section there is on only about one man who believes that his stock will eat sweet clover, and who succeeds admirably by growing and feeding this valuable legume to his animals during the summer months. Nevertheless, it is rapidly becoming known that on practically every farm where proper methods are practiced alfalfa will grow and cows will eat sweet clover.

To grow alfalfa the first requirement is to know the character of the soil. This determination is not hard to make. It is well known that in order to start well and grow successfully alfalfa must be seeded on ground rich in nitrogen, and practically free from acid. Nitrogen can be added to the soil without great expense by scattering evenly 10 or 12 tons of well rotted stable manure to the acre. Acidity in the soil can be determined by inserting litmus paper into a handful of the moist soil taken from the field which is to be seeded. Enough litmus paper can be secured from any drug store for 5c to make several tests in different parts of the field. The time for preparing the soil and seeding differs with different localities. Some places it has been found that seeding in the spring with a light sowing of barley or other cereal crop is best, but more generally does success result from summer seeding. Whichever the season found most advantageous, the rules for raising alfalfa are quite the same and in either event they must be followed faithfully, intelligently and without deviation.

The seedbed must be deep, firm, mellow, fine and moist. Such a seedbed is easier to secure in springtime than in summer, and that process which will insure such a seedbed must be followed. Summer seeding should be done from the 1st to the 10th of August and to secure the necessary seedbed at this season of the year is more difficult. Seeding may follow either summer fallowing, a soiling crop or a small grain crop.

After determining the presence or absence of acidity in the soil, by the use of litmus paper, the first step is to thoroughly disc the ground. Thorough disking means double disking lengthwise and crosswise one or more times. This process is necessary because dur-

ing the summer moisture from the clouds cannot be depended upon. Disking starts capillary attraction, which makes certain the securing of moisture from below the surface. Following this, 10 or 12 tons of manure should be spread over each acre. By this time sufficient moisture has been brought to the surface so that deep plowing is possible. The harrow should follow the plow and the disk the harrow, and again the harrow should follow the disk and vice versa until every clod has been reduced to soft, mellow, moist earth, and the seedbed has become firmed.

If the presence of acidity has been detected, which it probably has, two, three or even four tons of ground limestone should be evenly distributed and harrowed into each acre. This will sweeten the soil and permit the little bacteria so necessary to the permanent growth and development of alfalfa to survive and work for mankind. Harmful as are most bacteria, these little fellows are worth millions of dollars to American agriculture, and, if we would love them like we ought to love all our livestock, and give them the right chance to live and work for us, they would make us more money than any livestock we can raise upon our farms. Acid in the soil kills bacteria, so if we are even to permit them to live at all this acid must be neutralized by applying the lime. Unless we are willing to do this, we are not justified in saying that alfalfa will not grow in our community because we do not know; we have not given it even a reasonable opportunity.

Following liming, inoculation is the next step and is, regardless of what may be said to the contrary, quite as necessary as sowing the seed. It is true that in some places and on some fields alfalfa will thrive year after year without inoculation. This is the exception, however, and not the rule. I know that inoculation is a bugbear. Why it is I do not know, unless it is because it approaches so closely the scientific; and we are yet more or less in that old rut where we shy at book farming and science. Yet, science as it pertains to farming is just common sense intelligently applied and books merely tell how. There is no part of the process of growing alfalfa that is simpler than inoculating the soil or the seeds. It costs practically nothing and is the process that puts in the soil the bacteria that are the most industrious hired men we have. They exact no compensation, not even their board, at our expense.

To inoculate the ground, it is necessary to secure a few hundred pounds of soil from a sweet clover patch along the roadside or from a well established alfalfa field of the one neighbor in your community who has been sufficiently faithful to raise alfalfa successfully. An excellent method for distributing this soil is by the use of a fertilizer

distributor. This implement not being available, a box from 12 to 18 inches deep, the width and length corresponding to that of the harrow, should be built with a bottom made of slats placed sufficiently far apart so that, when the box is attached to the harrow and filled with inoculation dirt, the jar of the harrow will shake the dirt through the slated bottom and distribute it over the field while the harrow drags it into the soil immediately and before the sunshine has an opportunity to prostrate the bacteria it contains. This process is so simple that any boy on the farm can do it, and, yet, men who are otherwise most successful farmers think of it as a terrible task, and refuse to inoculate their soil and therefore repeatedly fail when they attempt to grow the most valuable crop that can be grown on the American livestock farm.

The seeding of alfalfa should be with a drill. Alfalfa seed costs too much money to waste, although, if a drill is not available, the seed can be broadcast and lightly harrowed in. A better stand can be secured and better use can be made of the seed by drilling to a depth of only one-half inch from 8 to 10 pounds of seed and then crossing the field with the drill, seeding an equal amount, making a total seeding of from 16 to 20 pounds of seed per acre.

Sweet clover is grown in much the same manner as alfalfa but in more instances proves successful when seeded in the spring than is the case with alfalfa. It is not quite but almost as particular in its demands for a sweet soil and inoculation as is alfalfa, but will grow on poorer land and stand more hardship. It makes a better grazing crop than alfalfa and is quite as good for soiling purposes but does not make as excellent hay. It is not to be recommended where alfalfa will grow successfully, but should be grown if alfalfa can not be, and then it will prove a stepping stone from the common hay to alfalfa, because sweet clover will inoculate and prepare the soil for alfalfa which will grow after sweet clover has succeeded.

In grazing or soiling alfalfa, care must be taken, else cattle will bloat. To eliminate the danger, cows should first be well filled with dry hay or other dry feed and never given alfalfa when it is wet or the dew is on. Sweet clover is less dangerous in its green state, and there are those who claim that sweet clover, unlike other leguminous plants, will not bloat cattle. This makes it an excellent soiling and pasturage legume.

As a matter of fact, all leguminous crops fit into soiling plants admirably and the clovers most common should not be overlooked. The manner of growing and using, however, need not be treated in detail at this time because the rules for growing clover as they apply in different sections are well known to the farmer, dairyman and

breeder. It is his business to grow these leguminous crops, and if he is successful he has made it a part of his life study to apply methods most conducive to their successful raising.

Very often, sweet clover, alfalfa and the commoner clovers are either not growing on the farm, or, in cases where they are, it may seem preferable that they be made into hay for winter feeding. It is true that with the exception of sweet clover they make such excellent hay that in most instances it seems advisable to provide substitutes for them as soiling crops in order that the legumes may be retained for winter feeding.

After eliminating the use of all foods thus far mentioned, the plan should be to arrange a series of succession of crops so that for every day during the summer there will be green feeds growing and ready to use. The most important to select are wheat, oats, rye, barley, peas, vetch, soy beans, cowpeas, corn, sweet corn, sorghum, millet and rape.

For early spring feeding wheat and rye should be sown at the rate of two bushels of seed per acre early in the September prior. One-half acre of each will provide liberal succulence for 15 cows from the middle of May until the 10th of June. The rye will be ready to feed first, and, after it has been used, the wheat will be sufficiently mature. The most acceptable seedbed can be made where other soiling crops have been removed early enough for proper preparation. This seedbed should be mellow, fine and deep, yet firm. Therefore, very thorough disking and harrowing recommend themselves rather than plowing, for three reasons: First, plowing is often difficult in the fall, owing to continued drouth. Second, it is not easy to provide a firm enough seedbed immediately following plowing. Third, more available moisture can be secured and less of it wasted by disking and harrowing rather than plowing. The seed may be broadcast, but, as is true of all other seeds under present conditions of high prices and endeavors to grow as large a tonnage as is possible per acre, it is much more advisable to drill the seed, placing them from one to two inches beneath the surface, where they will be in contact with the warm, moist earth and germinate quickly preparatory to responding strongly when the fall rains come.

There comes a period between about the 10th and 25th of June when nothing serves the purpose of soiling so well as one of the clovers, and it would seem advisable to provide at least an acre for use at this time in tiding over from winter wheat and oats to the time when peas and oats are ready for use. It may be possible to fill this gap by seeding, as early as the frost has left the ground, early oats on corn stubble ground well disked and pulverized. Furthermore,

it is usually the case that pasture grasses are sufficiently luxuriant at this season so the dairyman is justified in taking the risk of his cows securing sufficient food from grazing.

As early as advisable, or about the middle of April, one-half acre of oats and peas should be sown at the rate of one and a half bushels each. This being one of the most advisable of all soiling crops, half acre plots should be successively sown each ten days until the middle or last of May, for oats and peas will thrive and grow rapidly and luxuriantly until intense heat and drouth intervene, which, however, may hardly be expected before the latter part of July. Ground should be prepared for this crop in about the same manner as for oats, except that it should be disked deeper, if possible, to permit the placing of the pea seed at least three inches in the ground. In planting the oats and peas, the seed should not be mixed, but rather the peas should first be drilled at the rate of one and a half bushels and then the oats should be cross drilled in at a lesser depth. It may be possible that by deep seeding as much as one-half acre April 20th, 30th and May 10th and 20th more green feed than is necessary will be provided for 15 cows, in which event little need be the worry, for any of the crop not used for the purpose of soiling can be made into hay when the oats are in the dough stage. This roughage will make hay almost, if not quite, the equal of clover hay in feeding value and palatability, if it is properly cured and stored.

Thus far food has been provided for the portion of summer preceding August 1st. The need for green feed now becomes more urgent. Fortunately, there are crops that can be used for the purpose. Barnyard millet recommends itself. Sown successively at the rate of 16 quarts per acre each 15 days from the middle of May to the middle of June on plots approximating one-third acre, sufficient food will be provided for 15 cows all through the month of August. Unless the ground on which millet is to be grown is mellow and smooth, it should be plowed and carefully prepared by disking and harrowing. This crop demands a soil warm, deep, mellow and moist in order for rapid growth to follow quick germination. Whether the seeds are broadcast or drilled, they should be placed deep enough to come in contact with considerable moisture. If drilled, 16 or 17 quarts are necessary per acre, but if broadcast from 20 to 24 quarts are advisable for use.

Sweet corn is a better soiling crop than field corn to be used from the latter part of August to the middle of September. Two-thirds of an acre planted in the middle of May will provide food for 15 cows from the last of August to the middle of September, or in some instances, even from the middle of August, but one season

with another sweet corn should not be depended upon with a certainty until the latter days of August. Another such plot, planted June 1st, will complete the feeding period up to the last of September or the first of October, when field corn will be ready for use. It may be more advisable to depend on using from the regular field of corn after September 15th. At this time, in most localities, corn is ready for the winter silo. As soon as the silo is filled feeding from it may begin.

As a summary the tables herewith will prove an excellent guide for furnishing an unbroken soiling plan for 15 cows, but should be considered merely as guides, for the time of seeding, acres seeded, and time for cutting can be given only approximately, because the yield of these crops per acre and the time of season when they are ready to cut depend very largely upon those conditions which govern the growing of crops in all sections.

Another outline herewith anticipates the use of green clover and alfalfa.

Guide for Soiling Plan for 15 Cows

Crop	Seed per acre	Time of Seeding	Area	Time for cutting
Winter rye	2 bushels	September 1st	½ acre	May 15th to 30th
Winter wheat...	2 bushels	September 1st	½ acre	May 30th to June10th
Early oats	2½ bushels	As soon as frost leaves the ground	1 acre	June 10th to 25th
Oats and peas..	1½ bu. each	April 15th	½ acre	June 20th to July 1st
Oats and peas..	1½ bu. each	April 25th	½ acre	July 1st to 10th
Oats and peas..	1½ bu. each	May 5th	½ acre	July 10th to 20th
Oats and peas..	1½ bu. each	May 15th	½ acre	July 20th to Aug. 1st
Millet	15 quarts	May 15th	⅓ acre	July 25th to Aug. 10th
Millet	15 quarts	June 1st	⅓ acre	August 10th to 20th
Millet	15 quarts	July 1st	⅓ acre	August 20th to 30th
Sweet corn	15 quarts	May 15th	⅔ acre	Aug. 25th to Sept. 15th
Sweet corn	15 quarts	May 30th	⅔ acre	Sept. 1st to 20th

Field corn ready for green feed and silage.

Soiling with Green Clover and Alfalfa Available

Crop	Seed per acre	Time to seed	Acres	Time to feed
Rye	2 bushels	September 10th	1	May 15th to June 1st
Alfalfa	20 pounds	August 12th	2¼	June 1st to 15th
Clover	20 pounds	August 12th	1¼	June 15th to 25th
Peas and oats......	1½ bu. each	April 15th	1	June 25th to July 10
Peas and oats......	1½ bu. each	April 25th	1	July 10th to 25th
Alfalfa, 2d crop....	20 pounds	August 12th	2¾	July 25th to Aug. 15
Sorghum and cowpeas after rye.....	75 lbs. sorghum, 3 pecks peas	June 1st	1	Aug. 15th to 30th
Same after peas and oats..........	....	July 25th	2	Aug. 30th to Sept. 30

Two of the most useful soiling crops other than summer silage are not used extensively for feeding dairy cows, except along the Pacific coast, and especially in the Williamette valley. These are rape and thousand headed kale. Undoubtedly the specific reasons for this are that neither crop can be fed carelessly because of a tendency toward tainting milk, and that, unless care is exercised in pas-

turing and soiling cows on them, there is danger of bloat. However, in those sections where a study has been made of these crops and how best to use them they have been found very useful for stimulating a large and cheap flow of milk.

When cattle are well fed with hay and grain before being allowed to pasture on rape or kale—in fact, when the same precautions are taken as are necessary for pasturing clover and alfalfa—the danger from bloat is reduced to a minimum. Therefore, dry cows and young dairy animals may be pastured successfully, cheaply and advisably on these crops where proper precautions are taken.

When allowed to wilt before being used for soiling purposes, there is scarcely any likelihood of ill effects upon the animal's digestive system, so that, valuable as they may be in some sections for pasturage, the great usefulness of kale and rape is for furnishing green feed for soiling purposes. Used in this manner, the objectionable flavors and odors likely to be imparted to the milk can be avoided by feeding them immediately after milking only.

Sowing Rape

The planting of rape may begin as early in the spring as the soil can be gotten in good tilth. This is the most advisable season for sowing, because both rape and kale are favored by cool, moist climatic conditions, even though they withstand hot weather and drouth fairly well when properly cultivated. Rich, deeply plowed, well prepared ground should be provided. They are quick, luxuriant growers and demand much available plant food. The early seedings—those that may be assured of cool weather and sufficient moisture for 8 or 10 weeks—the time required for rape to reach the stage of growth suitable for use—may be broadcast or sown with a grain drill, using three or four pounds of seed per acre. Those plantings which are liable to suffer from hot, dry weather should be drilled at the rate of two or three pounds of seed per acre in rows of 24 to 36 inches apart and cultivated regularly to eliminate weeds and to conserve enough moisture in the soil to make it possible for the plants to grow vigorously.

By thus seeding rape on rich ground, that is properly prepared, the middle of April, excellent feed may be had by the middle of June; and that which is sown even as late as the middle of June in most sections will supply green feed during the hot month of August. In cutting rape care should be taken to cut the plants four or five inches above the ground, and this will permit a second crop to come along for feeding later.

There are three methods commonly employed in raising rape for fall pasturage or soilage. Two or three pounds of rape seed may be

sown with oats in the spring. The rape does not make large growth until fall because the oats take the advantage in the early growing season, and when they are cut the rule is that the hot weather and lack of moisture in the soil discourages the growth of the young rape plants. When the first fall rains come, however, growth begins in earnest, and green food in abundance is provided for feeding up to and even after the first severe frost because the well grown rape plant withstands much cold weather.

A second method is that of seeding three or four pounds of rape seed per acre in the corn just prior to the last cultivation, covering the seed with the cultivator. This plan provides a welcome seedbed and one so well shaded by the corn that the rape makes excellent growth by the time the corn is removed for silage or for shocking.

The third method, and least advisable one, is that of plowing stubble ground, or that on which potatoes have been raised, after the grain is cut or the potatoes dug and preparing a suitable seedbed for planting in rows that are to be well cultivated during the summer months, making it possible for the rape to withstand the drouth and weeds.

In the south rape should be sown in the fall from the first of September to the middle of October. It will respond well when the fall rains and cool weather come and grow all winter and up to the time when the hot, dry weather of early summer stops it. It, therefore becomes apparent that for the southern dairyman, who is willing to use the necessary precautions to guard against bloat and tainted milk, rape is a crop that can be very cheaply and easily grown for furnishing green feed throughout the period intervening between the late pastures of fall and the early pastures of spring.

Raisers of sheep and hogs use rape very largely in many sections of the United States for pasturage. It can be used in the same way by feeders of dairy cattle, but this is a very extravagant use of it. Cows grazing on rape pull up a large percentage of the plant by the roots, prohibiting further growth, and they also ruin much of the crop by tramping it out. Where it is found advisable to pasture cattle on this crop, two or more pastures should be provided so that before one field is grazed too closely the animals may be moved to another, thus permitting the field to renew its growth.

Thousand-Headed Kale

In the Willamette valley, where kale is grown very extensively, it is considered one of the very best crops that can be sown for stimulating milk production, especially because it can be fed throughout the entire winter and provides from late fall to early spring green feed that is considered by the western dairymen as being superior

to corn silage or any other winter roughage. In any community where climatic conditions will permit the growing and feeding of thousand-headed kale, the dairyman has a great advantage over those living in other communities, for it is possible for him to keep his cows on green feed every day in the year. The advantage he gains is not only along lines of economy of production but also along lines of producing large records. This suggests that wherever winters are as mild as they are west of the Cascade mountains, and such conditions prevail over most of the southern states, thousand-headed kale may be employed to excellent advantage by feeders of dairy cattle.

Seeding Kale

Like rape, this crop is seeded early in the spring. There are three methods employed. One of these is to prepare a suitable seedbed very early in the spring in which the seed is planted in hills two feet eight inches to three feet apart each way and later the hills are thinned out to the required number of plants.

The second method is to grow the plants seeded thickly in a bed and set them out in the same manner as is followed in setting out cabbage.

The third, and perhaps the most advisable plan is to sow the kale in drills on well prepared ground as early in the spring as possible, and in June or July the plants will have attained a size such that they can be transplanted. The ground which is to be used for this purpose should be tilled from early spring until this time. It is then plowed again and in each third furrow the plants are placed two and one-half to three feet apart. Care is exercised in so placing the plants that the fourth furrow covers the roots of them but not the tops. Each evening the plants thus plowed in are rolled to firm the ground and insure growth. Any space where the plants do not grow may be reset by hand later.

Kale grows so rapidly after this stage of its life that it can be cultivated only a few times until the tops reach from row to row.

By the middle of September or the first of October the crop is ready to begin feeding from. If all conditions have been favorable, a yield of 30 or 40 tons of feed per acre may be expected and this may be used to furnish green feed during the entire winter and until grass comes in the spring.

In sections where an occasional few days of weather which is cold enough to freeze the kale may be expected, a supply may be cut and kept where it will not freeze until the weather moderates, when the field supply can again be drawn upon.

In feeding value, although rape is not a legume, it ranks well as

a green roughage with legumes, and is found by both the chemist and the practical feeder to be more valuable for furnishing milk-making nutrients than is green clover. This fact, together with the ease with which it can be raised, and because it can be grown as a catch crop in so many ways, using ground while it would not be wasted for other purposes, indicates that rape should be more generally raised for feeding dairy animals than it is at this time.

Thousand-headed kale does not analyze so rich in feeding nutrients, ranking more nearly with pasture grasses, but because of its tremendous yield and the fact that in many sections it can be fed green all winter, it, too, well deserves the consideration of dairymen living in those sections where soil and climatic conditions will permit its growth and use.

Neither of these crops are to be recommended for silage or hay making purposes because of their coarse growing character and great amount of water they contain, but from the standpoint of furnishing a green, succulent, palatable, easily digested food that can be used during exactly the season of the year when such food is necessary for tiding cows over from one favorable feeding season to another, these crops are very valuable and can be used to excellent advantage in conjunction with other soiling crops that are more generally recognized.

CHAPTER XX.

ROUGHAGE FROM SMALL GRAIN AND MILLET

The crop census of 1909 showed that in the United States that year 4,324,878 acres of grain were cut green for roughage. This represents an area almost equal to that devoted to raising alfalfa or nearly twice as many acres as grow clover—exclusive of the combined timothy and clover fields. This census includes cowpeas, which are largely grown in the southeastern part of the country and which should be classified with leguminous hays. When cowpeas are eliminated from the acreage, it is found that a far greater area than in any other section is devoted to the raising of oats, wheat, rye, Emmer (Speltz) and barley in the coast states of Washington, Oregon and California, although in every state a few thousand acres are used for this purpose. In the far western states, grains are raised and cut green primarily for hay, while in other states they are grown more largely for nurse crops and the hay resulting from them is of secondary importance in many instances.

With much rapidity, leguminous hays are spreading over the country so that each year a proportionately less acreage will be used for raising grains for hay; but, because of their value in seeding down meadows and pastures, there will always be a supply of such hay available for feeding purposes. For this reason it behooves the feeder to have an understanding of their feeding values that he may use them according to their true merits and be prepared to properly balance the grain ration he would feed with them in order to secure satisfactory results.

All of the grains cut green provide a hay that is superior to timothy hay in content of dry matter, mineral matter, digestible protein and carbohydrates. They yield far greater tonnages per acre, and if cut at the right time and properly cured and preserved most of them are as palatable and as readily eaten as timothy hay. Yet, four times as many acres are devoted to the growing of timothy, exclusive of that which is grown with clover, than are used for growing small grains for furnishing roughage. This fact indicates that the thoughtful dairyman who is now depending upon timothy as a source of hay for his cows can well afford to plow up his meadow, devote it to growing grain crops for hay, if he is unable to grow a better variety of roughage, and raise a greater abundance of hay that is more valuable or an equal amount and devote portion of the land now in timothy to other crops.

In the Pacific coast states and some of the semi-arid regions wheat is very largely used as hay. Because of the value of the grain where the crop is left to mature, hay made from wheat is expensive, but, when harvested at the time the kernels are in the milk stage, a hay is provided that is somewhat more valuable than oat hay from the chemist's standpoint. However, it is not so palatable, so it can hardly be considered superior to oat hay by the practical feeder.

Beardless barley hay, and even hay made from the bearded varieties, may be classed as practically equal to wheat hay, but even greater precaution should be taken to cut it early to avoid the large percentage of unpalatable, woody stems and troublesome beards or awns.

Hay made from Emmer, or Speltz, as this plant is commonly known, is richer in protein than that made from either of the other grain products and is raised quite largely in the semi-arid regions. The objection to it is that the yield is not heavy, and, even though great care may be exercised in cutting it early, a large percentage of it proves unpalatable because of the woody stems. It is not eaten readily and much waste results from its use. Rye hay, although like Emmer hay, rich in protein, has the same disadvantages in that the stems are coarse, fibrous and unpalatable. The chief use of this cereal as a forage crop, is that of providing green feed rather than dry hay.

Of all the cereals, oats are used more largely for hay-making purposes. When cut while the kernels are in the milk stage and just approaching the dough stage, a very palatable hay results, and one which furnishes much feeding value, according to the chemist's analysis. Many practical feeders consider well-made oat hay almost equal to clover hay, where it is cut with the binder, left to cure in the shock and well stored. It is fortunate that such a good hay can be made from oats, because one of the most successful methods of seeding clover and other grasses to seed them with grains, which, if left to mature, would be cut in the hot, dry season, leaving the tender grasses to succumb. The fact that almost, if not quite, as much value can be secured from cereal crops by making them into hay before maturity is reached provides an opportunity for cutting them early and giving the grass an opportunity to get well under headway and gradually become acclimated before the adverse season of heat and drouth appears.

Table 1 shows the comparative values of each of these grain crops as hay.

Millet

In nearly every section of the United States one or more of the varieties of millet will grow, and in many parts millet is grown. Al-

though there are numerous plants that provide better green feed and dry forage than millet, there are definite reasons why every feeder of dairy animals should have a knowledge of its characteristics and feeding value.

Millet is universally recognized as a catch crop. For this reason it is grown more largely some seasons than others. A severe winter often kills clover and alfalfa so that, after waiting in vain for these crops to come, a quick maturing annual plant is necessary. A late spring, or a wet one, makes it impossible to seed grain crops on certain areas and this provides another instance which demands a plant that can be seeded late and yet mature. In fact, a very frequent occurrence is the necessity for resorting to a rapid-growing, quick-maturing plant to take the place of another which may be more desirable but which, because of abnormal conditions, is impossible to raise.

Millet should not be sown until the ground is warm, and then it germinates quickly and rapidly and reaches the harvesting stage, requiring only 60 to 90 days to mature for hay-making purposes. It yields from two to four tons per acre, according to climatic conditions, rainfall and the variety grown. It, therefore, recommends itself as a very excellent emergency crop. It has been shown that it yields more heavily than timothy and later it will be noted that it also excels timothy hay in feeding value. One of the chief reasons given by the dairyman for raising timothy is that, by seeding it with clover, a crop of hay is assured even if the clover fails. A wiser plan by far would be to seed the clover by itself, trusting to secure a stand, and, if failure results, millet can be sown as a catch crop and more roughage of a better quality secured than if timothy were depended upon.

Table No. 1—Feeding Value of Cereal Hays

				Digestible Nutrients		
100 pounds	Water	Dry matter	Mineral matter	Protein	Carbo-hydrates	Fat
Emmer (Speltz) hay	7.7	92.3	9.3	6.5	44.3	0.9
Rye hay	8.2	91.8	5.8	6.4	46.0	1.1
Barley hay	7.4	92.6	6.4	4.6	48.2	0.9
Oat hay	12.0	88.0	6.8	4.5	38.1	1.7
Wheat hay	8.1	91.9	6.4	4.0	48.5	0.8

Table No. 2—Feeding Value of Millets

				Digestible Nutrients		
100 pounds	Water	Dry matter	Mineral matter	Protein	Carbo-hydrates	Fat
Millet, (Barnyard)	13.5	86.5	8.2	5.1	40.5	0.8
Millet, Hungarian	14.3	85.7	6.3	5.0	46.0	1.8
Millet, German	8.7	91.3	6.9	4.8	49.7	1.7
Millet, Broom Corn	9.3	90.7	5.9	5.3	49.5	1.6
Millet, Pearl	12.8	87.2	9.0	4.2	43.8	0.8
Millet, Wild or Indian	6.7	93.3	6.9	6.4	49.5	1.5

An objection that may be lodged against this plan is that millet, being an annual, does not provide a permanent meadow as does timothy, but this in reality may be an advantage, for it makes it possible and creates an opportunity each year to attempt raising the legume which provides hay of a quality greatly superior to any of the nonleguminous grasses.

Again, it is often necessary for dairymen to purchase roughages, and, as millet is not considered a safe feed for continuous feeding of horses, it can usually be purchased at a very reasonable price in a locality where it is grown. For feeding purposes, the common fox tail millets, which include the German and Hungarian varieties, are preferable and more customarily grown. Several other varieties, including Japanese millet, sometimes known as the "billion-dollar" grass, Pearl millet and Teosinte, produce larger crops, but, because they grow coarser, they are not so readily eaten and are less desirable for feeding purposes.

Millet should be harvested shortly after it blooms. If cut sooner than this, the hay has a decided laxative effect upon the animal, while, if left until the seed ripens, it is less palatable, and, the seed being very hard, is less digestible.

Compared with timothy hay, the common fox tail millet may be said to be more palatable and more nutritious. Even though objectionable as a feed for horses on the score of the supposed ill effect upon the health of the animal, this objection does not apply to it as a food for cattle.

By referring to the food nutrients contained in low protein hays, the feeder will recognize by the accompanying table compiled from Henry & Morrison's "Feeds and Feeding," that the varieties of millet are richer in every constituent denoting feeding value. This is particularly true of the mineral elements.

CHAPTER XXI.

SORGHUM

There are two great classes of sorghum—the saccharine and the non-saccharine. Both have been used largely for feeding dairy cattle in the past, and they will be used more extensively in the future, because the dairy cow is becoming more prevalent in those sections where sorghums are grown. The area is rapidly spreading over which the saccharine varieties, because of the merits of these varieties for feeding, are grown for forage purposes.

Non-Saccharine Sorghum

The non-saccharine sorghum varieties are of two groups—the kafir corn group and the durra group. The durra group which includes Jerusalem corn and yellow milo, is grown to some extent in the southwest, but is considered less valuable than the kafir group, except in the very dry regions and in high altitudes. Both groups are drouth resistants. With 10 or 12 inches of rainfall during the entire growing season both will mature. And it is in this respect that the durra varieties have the advantage over the kafir group. Both will practically suspend growth during extremely dry periods and later resume growth after it rains. If, however, the rains come too late, kafir corn often fails to mature, but the durra group, especially the yellow milo, will continue to grow sufficiently to produce some seed, regardless of conditions.

Therefore, the non-saccharine sorghums, of which kafir corn is of greatest importance and most widely grown, must be used as feed for dairy cattle in Oklahoma, Kansas, Texas and portions of California, Colorado, New Mexico, and, in fact, wherever a dry land crop of this character is necessary throughout the southwest.

Non-saccharine sorghums are used in substitution for corn and in quite the same manner. Like corn, they may be used for soiling or silage making purposes. Used for green feed, they are especially desirable in the sections where they grow, because they are ready to cut and feed during the hot months of July, August and September, when other green feeds are scarce. For silage, kafir corn is about equal to corn, provided it is ensiled after the seeds are hard and when very little juice can be squeezed from the stalk by twisting it with the hands. If allowed to reach the stage of maturity, an excessive amount of moisture and acid will not be present in the resulting silage.

Cattle are sometimes pastured on kafir corn, but this is not advisable in feeding dairy cows. It is far more economical to cut the kafir, even as it is more advisable to cut green corn and feed it as a soiling crop. It is doubly advisable, because at certain seasons of the year, when abnormal conditions exist, brought about by the growth of the plant being checked by drouth or other reasons, prussic acid becomes present in the plant in amounts deadly to cattle pastured on the kafir field. This danger is overcome when cattle are soiled by wilting the green material and feeding other feeds with it.

The varieties of non-saccharine sorghum other than kafir corn have little value when used as fodder or stover, because they become very dry and pithy and lack in palatability so they are not relished by cows. Kafir corn fodder has about the same feeding value as corn fodder, but the more economical method of using the dry plant is to remove the heads, to be ground and fed as grain, leaving the stover to be used as roughage. Kafir corn stover compares favorably with corn stover and should be used in the same way.

To be of greatest usefulness, the heads containing the grain should be thrashed. The seeds or sorghum are small and very hard, therefore not readily digested when fed whole. Even as it is advisable to grind all grain that is fed to dairy cattle, it is doubly advisable to grind sorghum grain. At the Oklahoma Experiment Station it was found that 100 pounds of kafir corn meal contained as much digestible matter, when fed to cattle, as 167 pounds unground. Chemical analysis show that kafir grain, milo grain, feterita grain, durra grain, kaoliang grain, sorghum grain and broom corn seed rank well with Indian corn but are not so rich in fat. Where they are grown they may be used in place of corn for dairy feeding purposes and good success obtained when one keeps in mind that from the standpoint of practical results one pound of the non-saccharine seeds ground are equal to four-fifths or seven-eighths of a pound of ground corn. Because of their carbonaceous character and low content of digestible protein, they should be used in dairy rations exactly as ground corn is used, and the rations balanced in the same way with nitrogenous foodstuffs.

Saccharine Sorghums

The saccharine sorghums are the ones most generally known to dairy farmers outside of the western states. In every section of the eastern two-thirds of the United States they are grown more or less for soiling purposes, silage and hay. There are few crops that can be grown which will furnish as large a volume of carbonaceous roughage and do it so cheaply as will the saccharine sorghums.

There are many varieties, but of these the Sumas and the Amber are the two best to grow for forage purposes. The Sumac sorghum is a late maturing variety, but is the heaviest yielder, grows the greatest abundance of leaves and contains the most sugar. It is the most suitable kind to grow in the area lying south of a line drawn through the middle of Oklahoma, Missouri and Kentucky. North of this line Amber cane or sorghum is the most advisable variety. Its stems are slender, sweet, juicy, and, when properly harvested, cured and stored, they are very tender and palatable. Amber cane is the earliest maturing variety, and, if allowed to mature, will form seeds in 90 or 100 days.

For pasturing, saccharine sorghum is not to be recommended unqualifiedly. There are many other grasses superior for this purpose which are not liable to develop prussic acid and become poisonous to cattle. Furthermore, sorghum is so useful for soiling and hay-making purposes that it should be harvested rather than wasted by permitting animals to graze it.

For making silage many crops are superior to sorghum. It should be ensiled only when corn and other crops more useful for the purpose are not available, or when the only means by which it can be saved is by putting it in the silo.

When circumstances occur making it necessary to use it for silage, the sorghum should be allowed to reach that stage of maturity

Feeding Value of Saccharine and Non-saccharine Crops

				Digestible Nutrients		
100 pounds	Moisture	Dry matter	Mineral matter	Protein	Carbo-hydrates	Fat
Green Roughage						
Kafir	76.4	23.6	1.9	1.1	12.4	0.4
Milo	77.3	22.7	1.4	0.8	12.7	0.3
Durra	77.6	22.4	1.8	0.9	12.0	0.4
Broom corn	77.1	22.9	1.7	0.9	12.1	0.3
Sorghum	75.1	24.9	1.4	0.7	14.1	0.6
Silage						
Kafir	69.2	30.8	2.5	0.8	15.3	0.6
Durra	79.7	20.3	1.9	0.6	9.9	0.4
Sorghum	77.2	22.8	1.6	0.6	11.6	0.5
Sugar cane tops	76.6	23.5	1.9	0.5	12.2	0.2
Dry Roughage						
Kafir fodder	9.0	91.0	9.4	4.1	45.0	1.7
Kafir stover	16.3	83.7	8.3	1.7	43.1	1.3
Milo fodder	11.1	88.9	9.9	1.9	36.3	2.8
Sorghum fodder	9.7	90.3	7.8	2.8	44.8	2.0
Durra fodder	10.1	89.9	5.2	1.0	43.6	1.8
Broom corn fodder	9.4	90.6	5.7	0.6	44.6	1.1
Grain						
Kafir	11.8	88.2	1.7	9.0	65.8	2.3
Kafir heads, ground	12.5	87.5	2.8	6.1	56.6	2.0
Milo	10.7	89.3	2.8	8.7	66.2	2.2
Milo heads, ground	10.3	89.7	3.1	6.3	58.1	1.9
Feterita	10.8	89.2	1.5	9.3	66.6	2.5
Durra	9.9	90.1	2.0	8.2	67.9	2.7
Shallu	9.7	90.3	1.6	10.1	66.3	2.6
Kaoliang	9.9	90.1	1.9	8.5	67.0	3.3
Sorghum	12.7	87.3	1.9	7.5	66.2	2.6
Broom corn seed	11.8	88.2	2.9	8.3	62.9	2.6

where seeds have been matured and the stems become free from moisture so that by twisting them in the hand only a small amount of juice can be squeezed out. If ensiled before this stage is reached, the silage will be very sour on account of the large percentage of moisture it contains. If left to mature, however, a fairly sweet, palatable silage will result, and its feeding value will be almost as large as that made from corn.

Making hay of the saccharine sorghums is the best use to which they can be put. For this purpose they should be sown thickly and most preferably planted with a wheat drill at the rate of from one to two bushels per acre, according to the humidity of the region where they are to be grown. The stand and growth can be encouraged by harrowing the field as soon as the young plants are up, and, even when they have reached a growth of from one to two feet, the crop can be improved by cultivating with a weeder. This encourages rapid growth, hastens maturity and insures a growth of more numerous and, therefore, finer stems and a greater abundance of leaves.

It is very often the case that sorghum is cut too green to make the best quality of hay. It should not be cut until after the seeds have formed and reached the milk stage. It should then be cut at once, because, if left longer, these seeds become hard and less digestible. An excellent way to harvest the crop is to cut with a grain binder, placing the bundles in small shocks to cure. The common custom is to cut sorghum with a mower, leaving it to cure in the hot sun. This robs it of much of its palatability so that a more advisable plan is to rake it shortly after cutting and, as soon as it has wilted well in the windrow, place it in small sized cocks where it may be left to thoroughly cure in the shade. As soon as it has cured sufficiently, it should be carefully stacked or stored where it will remain dry and protected from the elements until it is to be fed.

The feeding value of saccharine sorghum compares favorably with timothy hay. From the standpoint of chemical analysis it is quite equal, and practical results secured from its use are even superior because it is more palatable. The sugar it contains has a very beneficial effect upon the digestive apparatus of the animal, and, when fed in conjunction with other feeds sufficiently rich in protein to balance the ration, its use as hay is much to be advised. One point that should be well remembered, however, is that sorghum is a carbonaceous feed. The claim is often made that it has a tendency to decrease milk flow when fed to dairy cows. Several of these claims have been traced down and it has been found that the basis for them was that cows had been changed from roughages rich in protein to sorghum, without so re-arranging the remainder of the

ration that the protein content of the ration was kept up to standard. Under such circumstances it is only to be expected that cows will decrease in their milk flow. This, as will readily be seen, is not specifically the fault of sorghum but it is due to a lack of knowledge on the part of the feeder relative to the feeding values of different roughages, and the demand of cows for materials out of which all constituents of milk are made.

Sorghum, like millet, timothy hay and other low-protein roughages, is valuable to use where the remainder of feeds, such as alfalfa hay and cottonseed meal, are high in protein. In most sections the available feeds are largely carbonaceous in character, and leguminnous hays are much more valuable. But, the point in favor of sorghum is the same as that in favor of millet, when compared with timothy hay. A larger tonnage of equally valuable forage can be raised on the land where timothy now grows.

The table given on page 151 gives definite information relative to the feeding values of the saccharine and non-saccharine crops in their different forms.

CHAPTER XXII.

LEGUMES

Legumes, chief among which are the clover, alfalfa, cowpeas, soy beans, vetches, field peas, lespedeza and sweet clover, may be roughly classified as those plants that bear pods and gather nitrogen from the air. They are the most valuable plants that can be raised on the dairy farm. Furthermore, there is hardly a dairy farm in America that one or more legumes cannot be successfully grown on.

The first consideration of any farmer should be that of maintaining or even enhancing the richness of his land. Every dairyman is imbued with this fact, which is the fundamental reason why many farms are devoted to dairying instead of other phases of agriculture. One of the greatest values of legumes is that they, like no other class of farm crops, aid in enriching the soil while they grow.

The most quickly exhausted fertility element is nitrogen. Also, this is the most expensive to return in the form of commercial fertilizers, costing, as it does, 15c per pound even in normal times. Fortunately, it is the cheapest and easiest to return to the soil when legumes, that have the power of taking it from the air, are raised. As a matter of fact, four-fifths of the air is composed of this valuable and essential element; but not until 1886—when Hellriegel, a German, explained to the world that legumes had the power of taking nitrogen from the air and putting it into the soil—was it known how to take advantage of the enormous amount of nitrogen over every acre of ground and place it in the soil in a form suitable for growing future crops.

If legumes had no other value than this, they would be the most profitable crops that could be grown on the farm. It is recorded by Jos. E. Wing that in a season's crop of four tons of alfalfa there is nitrogen worth $26.40, which has been gathered largely by the bacteria on the roots of the plant. This, however, is not the only fertilizing value, for in the same four tons of alfalfa there is to be found potash worth $6.40 and phosphorus worth $2, making a grand total of $34.80 that may be credited to this valuable legume for fertility made available on one acre in one year.

On the roots of all legumes that grow successfully and luxuriantly are to be found lumps that are termed nodules, in which live millions of bacteria that have the power of taking nitrogen from the air, fixing it in the soil and furnishing it to the growing plants. Without the existence of nodules on the roots legumes do not grow

well, and, if they did, they would be no more valuable than non-leguminous plants for feeding purposes, because no nitrogen would be gathered from the air to build protein in the plants.

Potash and phosphorus are not taken from the air, but, because of the great depth to which legumes send their numerous roots, these two essentials for plant growth are brought to the surface and made available for other crops with less root system.

The final value of the legume as a fertilizer is brought about by the decaying of the many fibrous roots, which process adds humus to the soil. Humus is not a fertilizing element but its value is physical in that it loosens the particles of earth and permits the air to enter, warms the soil and adds to its moisture-retaining efficiency.

Great as are these values, much of the advantage gained by raising legumes is lost if they are sold in their raw state, for, although they leave as much nitrogen in the soil as is removed by the stems, each ton sold off the farm carries with it much potash and phosphorus taken from the earth. To be most valuable they must be fed to livestock, and the manure returned to the land. In the feeding of the legume the direct value becomes apparent, for the very nitrogen stored in the plant represents the protein which is the costly nutrient that is so essential in balancing rations, and the necessary nutrient from which bone, muscle, blood, hair, horns, and the proteids of milk are made. The legume is the only plant which can be grown upon the farm to eliminate or even lessen the necessity of purchasing high-priced commercial foodstuffs, such as linseed meal, cottonseed meal, bran, etc., to balance the ration and furnish protein. By their use the farmer can grow nitrogenous feeding material far more cheaply than he can purchase it, and every year finds protein feeds becoming higher in price, making the raising of legumes the more advisable. As an illustration of the feeding value of legumes, it may be said that most of them are nearly equal ton per ton to bran, which today is so well recognized as a standard foodstuff for farm animals that the demand can hardly be supplied, even though the price has continually, raised until now it sells for from $22 to $29 per ton. Four tons of leguminous hay is not an exceptional annual yield for an acre, and compared with bran at prevailing prices the money value of a season's crop can easily be estimated. Add to the estimate the richness that has been added to the soil by the legumes having grown there, and every thoughtful dairyman will put forth his best efforts to grow one or more of these nitrogen-gathering plants in the future. No dairyman who does not make use of these plants in his farming and feeding operations is taking full advantage of the op-
available feeds are largely carbonaceous in character, and legumi-

nous hay and good cows is one that cannot be equalled otherwise. Nearly every state experiment station has performed experiments that have shown conclusively the value of these crops as compared with non-leguminous grasses.

Although each year finds a great increase in the acreage of legumes grown in all parts of the United States, they are not being grown as largely as they should be, and millions of acres where timothy and non-leguminous grasses are now growing should be converted into protein-producing areas to furnish the balancing power for the carbonaceous grains, such as corn, barley, kafir corn and other crops, that are so largely and necessarily raised.

The chief reason, no doubt, that the nitrogen-gathering plants are not more universally grown is due to the fact that they are believed to be more difficult to raise, more difficult to harvest and less likely to withstand hard winters and other adverse conditions. They are not more difficult to raise than other crops, provided one recognizes and follows closely the rules that are essential for securing a stand that will grow vigorously. Legumes demand a sweet soil and the use of much lime. Also, to get a start in life, they prefer a rich soil and a well prepared seedbed. Soil that has not previously grown legumes does not possess the particular bacteria that live on the roots of these crops. Possessed of this knowledge, he who would grow the valuable plant must know that the first thing he should do is to cover the field liberally with well-rotted manure—12 tons per acre is not too much. This should be plowed under deeply, and a smooth, firm seedbed provided by much harrowing and discing. A better seedbed must be prepared for legumes than for most other crops. This is another advantage in favor of legumes, for all men know that any crop will grow better and yield heavier, other things being equal, on a well prepared seedbed than on a poorly prepared one. If the soil is acid, and seemingly most soils are, leguminous crops will not grow satisfactorily. All crops will yield better on sweet soil than on acid soil, therefore, the very fact that these plants demand a correction of the acidity is another point in their favor. They render apparent the fact that ground limestone should be applied at the rate of two, three or even four tons per acre to make farming profitable and the growing of legumes possible.

When the ground is in the proper tilth and the fertility and sweetness of it up to standard, then the final preparation for seeding is to inoculate either the seed or the soil with that bacteria demanded by the specific legume that is to be grown. This is the bugbear that causes more failures than any other one factor except the absence of lime in the soil. These are the two important factors. The one that

will practice liming and inoculation will succeed, if he is a good farmer. All others will fail in nine cases out of ten. The rules for growing legumes, so well established by science and practice, must be closely followed if one is even to hope for success.

When a good stand of a perennial legume has been secured, it should be protected in a cold climate, where a bed of snow does not cover the ground all winter, by top dressing with a light coat of manure. Such dressing eliminates alternate freezing and thawing, which heaves the roots of the soil, the main reason for winter killing. The manure serves a secondary purpose in that it further enriches the soil and causes the plants to start earlier in the spring and make a more vigorous growth than though they had not been covered.

In humid climates the harvesting of all legumes is more difficult than the harvesting of non-leguminous plants, because they produce more often. The first crop is ready to cut earlier and usually at a rainy season. Because of this, the grower should be specially prepared for saving his hay crop. The best of hay is always made by curing it in the shade, and this is doubly true of legumes. As soon as the hay is cut and thoroughly wilted, it should be cocked, covered with hay caps and left to cure sufficiently to store in stacks or barn. True, this incurs some expense, but nothing compared with the extra value of good hay over poor hay, or leguminous hays over that made from non-leguminous grasses.

All of the legumes are excellent for soiling purposes. Where it is possible to grow both alfalfa and clover, proper management will make it easy to have green feed from them every day from the time they are ready to begin cutting in the spring until frost has killed them in the fall. Cowpeas, sweet clover, lespedeza, and field peas can be used in the same manner, and, because they are extremely palatable and rich in feeding nutrients, they will stimulate a regular, persistent, large milk flow and keep the animals eating them in the very best possible condition.

Leguminous grasses are not to be recommended unqualifiedly for silage-making purposes. The large amount of protein they contain in proportion to carbohydrates is, no doubt, the reason why a foul-smelling silage results from their use unless they are allowed to almost fully mature before being ensiled. Animals eat them readily in the form of silage, regardless of the objectionable odor, and they prove to be stimulating to large production. The chief objection is that because of the penetrating odor the silage is very disagreeable to handle. If legumes are to be used for silage-making purposes, they should be mixed with other materials, such as straw, corn, green kafir corn or other crops rich in carbohydrates. Used in

this manner they are very advisable for supplying the protein which is necessary to balance the carbohydrates furnished by the other materials, thus assuring a very excellent quality of silage and a well balanced, succulent feed.

The excellence of legumes for feeding purposes, either as hay, green feed or as a supplement to other materials for silage, is such that one or more of them must be grown on every dairy farm if milk production is to be as large and profitable as it should be.

CHAPTER XXIII.

ALFALFA

As king of all crops, corn holds the undisputed title, and his queen is alfalfa. The farm on which they reign together is an agricultural kingdom unto itself. There are no foods that can be grown or purchased that will provide a basic ration for dairy cattle that will exceed this combination. No roughages will grow young stock and maintain animals as well, or stimulate so large and economical a milk yield. There are no crops easier to grow for the one that knows how to grow them, no crops that will co-operate better in maintaining farm fertility and providing all nutrients necessary for a balanced ration, no crops that yield more abundantly year after year, no other crops that can be grown so generally over this country and no other crops so palatable to dairy cattle.

The farm that will grow large crops of corn is valuable, the farm that will grow large crops of alfalfa successfully is a prize, but the farm that will grow both corn and alfalfa abundantly has no superior on earth for the man who milks cows. This is common knowledge, and it is rapidly becoming an undisputed fact that nearly every farm in the United States will grow corn good enough for silage, at least, and alfalfa good enough for hay and soiling purposes; yet the 1909 agricultural statistics show that over the entire country only 4,707,146 acres of alfalfa were grown—and only 183,633 acres of this grew east of the Mississippi River—as compared with 14,686,393 acres of timothy, exclusive of the 19,542,382 acres of land that grew timothy mixed with clover. The reason for this poor acreage showing of alfalfa is that, comparatively speaking, alfalfa is a new crop in most sections. There has existed a prejudice against it because of a general belief that it could not be successfully grown. This idea is rapidly being dispelled in every part of the country by those who, realizing the great values of the crop, have succeeded in growing it by persistently and intelligently working to secure and maintain a stand so that each year the acreage utilized for growing alfalfa is doubling and trebling.

When the next agricultural census is taken the figures relating to this important legume will be vastly greater than they were in 1909. There are many reasons why they should be. From the standpoint of the dairyman many reasons exist, even after leaving out of consideration the facts, so well known, that alfalfa yields so largely per acre and is a most profitable crop to raise; that as soon as a farm

grows alfalfa successfully its selling value increases; and that, like other legumes, alfalfa builds up the richness and increases the producing value of the farm instead of depleting the soil and lowering its productivity as do all leguminous plants. Alfalfa is the best single roughage that can be used for feeding dairy cows. It is very palatable, has a favorable physical effect upon the digestive apparatus of the cow, furnishes feeding nutrients cheaply, encourages rapid growth of young animals and is especially stimulating to milk production. The value of alfalfa as a food where protein and mineral matter are necessary is revealed by the chemical analysis compared with the composition of timothy hay, which is so frequently grown on lands where a good legume, such as alfalfa, should grow.

Although protein and mineral matter are not the only factors denoting value of a foodstuff, it is true that carbohydrates are grown most abundantly on most farms. This necessitates the purchasing of protein and ash, where leguminous hays are not raised, in order for a balanced ration to be provided. Timothy hay, for instance, can be used to take the place of a portion of the corn, stover or other carbonaceous feeds usually grown, but it will not suffice to furnish those nutrients for which cottonseed meal, oil meal, gluten feed, bran, etc., are purchased to balance up home-grown feeds. Alfalfa, as the table on page 162 implies, is nearly twice as valuable as timothy for furnishing mineral matter and more than three times as rich in protein. This, together with the fact that three tons of alfalfa can be grown where one ton of timothy now grows, shows the advisability of strenuous attempts being made to raise alfalfa.

Not only does the chemist find alfalfa much superior to timothy, but experiments demonstrate that cows find the same difference to exist. In 1910 an experiment was carried on by the University of Illinois to determine as closely as possible the comparative values of these two hays. A herd of 16 cows was divided into two lots of eight each. The records of feed and milk were kept for 25 weeks—from November 26th to May 20th—but as 13 weeks were used for preparatory and subsequent feeding the real test lasted just 12 weeks. During this time each lot of cows received alfalfa hay six weeks and timothy hay the other six weeks. All of the cows received the same ration otherwise, which consisted of mixed grains and corn stover.

After concluding this important test, the following conclusions were drawn by Fraser and Hayden:

"The total amount of milk produced by both lots for the six weeks during which they were fed alfalfa was 18,496 pounds and for the six weeks fed timothy it was 15,704 pounds. The difference in milk between these two periods was 2,792 pounds, which is 834

pounds in favor of each ton of alfalfa over timothy. This total difference of 2,792 pounds of milk, at $1.30 per 100 pounds, the price received, was worth $36.30. Three and thirty-four hundredths tons of hay were fed during this time. Therefore, in this test, alfalfa hay was worth $10.86 per ton more than timothy. The average yields per acre obtained in Illinois are approximately four tons of alfalfa hay and one and one-half tons of timothy, when figured on the above basis.

"The value of the alfalfa will vary with the price received for the milk, and for this reason the following table of values has been constructed:

Shows the Greater Feeding Value of Alfalfa Hay Than of Timothy, with Milk at Different Prices

Milk per 100 pounds	Value of alfalfa per ton, above timothy	Value of alfalfa per acre, above timothy when timothy is worth $10 per ton. (Alfalfa 4 tons per acre; timothy 1½ tons per acre.)
$1.00	$ 8.36	$58.44
1.10	9.19	61.76
1.20	10.03	65.12
1.30	10.86	68.44
1.40	11.70	71.80
1.50	12.54	75.16
1.60	13.38	78.52
1.70	14.21	81.84
1.80	15.06	85.24
1.90	15.88	88.52
2.00	16.72	91.88

"It must be borne in mind that the above figures can be applied to alfalfa only when fed with the feeds used in this test, or with other similar feeds."

At the same experiment station a test was conducted for the purpose of comparing the value of alfalfa hay and bran for feeding dairy cows, and the conclusions were that alfalfa is equal to or a little better than bran for milk production under the conditions which exist on most dairy farms.

A very important use can be made of alfalfa for soiling purposes. It grows so rapidly that very early in the spring its use may be started. A few acres will soil a large herd of cows all summer because by the time the last of the first crop is cut at one end of the field the first of the second crop is ready to cut at the other end, and, as rapidly as green feed is needed, it is ready to cut in some portion of the fiield. There is no other one crop that will furnish, with such regularity and such certainty, green feed abundantly every day from early spring till late fall as alfalfa. Fed as a soiling crop, it is found to be extremely valuable and a very cheap source of feed for tiding cows over the hot days of summer drouth, when, of all times of the year, they suffer most when not protected from heat and flies and fed

some food supplementary to the pastures that so often afford almost no food during such periods.

Table No. 1

100 pounds	Moisture	Dry matter	Ash	Digestible Nutrients: Protein	Carbo-hydrates	Fat
Alfalfa hay	8.6	91.4	8.6	10.6	39.0	0.9
Timothy hay	11.6	88.4	4.9	3.0	42.8	1.2

The experience of the writer denotes that, properly used, alfalfa hay can be fed to excellent advantage not only as a roughage, but, when cut into quarter-inch lengths, it may be used in the grain ration in substitution for bran and other concentrated protein feeds.

At the St. Louis World's Fair I had the experience of feeding one of the herds that contested in the greatest demonstration that has ever been performed for large and economical milk production. In view of the fact that prizes were to be awarded on both the amount of milk and butterfat yielded and the cheapness with which they were produced, it became necessary to select and combine feeds that would at once stimulate production that was large and cheap. This is really the problem which presents itself on every dairy farm in America, so that every feeder's problem is the same as the one presented in the instance referred to.

Chemical analysis shows good alfalfa hay to be practically equal to bran. When cut into short pieces and mixed with the grain ration it cannot be said to be as palatable as bran and, because of its physical character, it does not mix as well in the ration. The problem, then, is to prepare the alfalfa so that it will mix readily with the other feeds and be equally palatable. In the St. Louis test the cows were fed three times daily. Just before feeding them each time, two pounds of cut hay per cow was moistened by steaming just sufficiently to soften the stems and yet not cook them. While yet warm the cut alfalfa was mixed thoroughly with the grain. The moisture caused the grain particles to adhere to the small pieces of alfalfa stems and leaves so that the resulting mass was very bulky and so palatable—giving off as it did a very sweet aroma—that without exception the cows ate it with avidity. Rapidly they became accustomed to this ration of grain, made even more palatable and much more bulky by mixing it with the alfalfa, so after a time they showed little desire to eat a grain ration without cut alfalfa hay mixed with it. In this manner the cows were induced to eat six pounds more alfalfa hay and much less expensive grain daily.

Not only was there a saving of grain made but that grain which was fed was digested much more thoroughly and efficiently than

though it had been fed without the hay. In other words, hay fed in this manner has a mechanical value which, in some instances, is almost as great as its chemical value. Ruminating animals do not masticate their food as do non-ruminating animals when they first eat it. The cow swallows her food as she eats it. When she finds time she regurgitates and masticates it. This process we call chewing the cud. Where concentrated foods are given without light, bulky feeds, mixed with them, they are not completely regurgitated for mastication and, because they pass on to the other stomachs without undergoing this first process of digestion, are never thoroughly digested and a portion of them pass on through the digestive canal and are wasted—even worse than wasted because they tax the digestion of the cow without accomplishing anything. When the cut hay is fed with the heavier grain, the particles of which adhere to the light, chaffy pieces of hay, the entire mass is rendered so light and bulky that all the feed is returned to the mouth for mastication, during which process the saliva is mixed with the feed. This starts the process of changing the starches into sugar, which is the first and preliminary process of digestion which renders thorough and complete the final digestion and assimilation of the valuable nutrients. By following this plan of feeding, one is able to save much expensive food that would otherwise be wasted, and the likelihood of overfeeding cows is practically, if not entirely, eliminated.

It is not always that steam is available for moistening and softening the stems but hot water may be used, or, better yet, water in which molasses has been mixed at the rate of one quart of molasses to two gallons of water. By thoroughly moistening the cut hay in this manner and mixing it with the grain, one of the very best and cheapest feeds possible to provide can be prepared. If I were asked to name one principle of feeding most conducive to large and economical production, which at the same time would have a tendency to protect the persistency, health and future usefulness of the cow, I would say that, greater than all other principles, provided a suitable and an abundant ration was being fed, the mixing of some moistened roughage, a leguminous hay preferable, cut or chaffed, with the grain ration at the rate of from four to six pounds daily is the best. To utilize this plan requires some effort, and to accomplish it with expediency requires a large box in which the rations can be mixed, but it is well worth the effort, especially where conditions are such that the grain cannot be fed mixed with the silage or other roughages. Fed in this manner there is little doubt that alfalfa hay is at least equal in feeding value to the best of bran.

The conclusion should not be drawn from this that all hay should be fed in a cut or chaffed form. Experience denotes that cows appreciate a portion of their hay in regular lengths and, seemingly, other than that portion which is mixed with grain, unchaffed hay is more palatable and eaten with greater avidity. In this form it is doubtful if alfalfa hay is quite as valuable as bran, but it is so nearly equal in feeding value and chemical analysis that its usefulness can well be understood.

There is a belief that a vast difference in feeding value exists with regard to the different cuttings of hay, but whatever difference there may be is accounted for largely by the relative amounts of the hay eaten and wasted because of its physical condition. Hay differs greatly as a result of the manner in which it has been cured and preserved. Only two-fifths of the total weight of the alfalfa plant is in the leaves, yet three-fifths of all the protein contained in the plant is found in them. One hundred pounds of stems contain no more protein than 44 pounds of leaves, and, furthermore, because the leaves are the most palatable portion of alfalfa, it is readily seen that the hay which contains the largest amount of leaves in proportion to the stems, regardless of whether it is the first, second or third cutting, is the most valuable. It is a plan followed by some feeders, who attempt to make large records, to shake the leaves from the stem, feeding them to the cows on test, feeding the remaining portions of the plant to young animals that are not working or to other animals on the farm.

Analysis shows alfalfa leaves to be richer in feeding nutrients than bran, and experience shows them to be even more valuable for feeding purposes. Alfalfa that has been exposed to the elements contains much less feeding value than alfalfa that has been properly cured and well stored.

At the Colorado Agricultural Experiment Station it was shown that as much as 40 per cent of the feeding value of alfalfa hay is lost by two weeks' exposure to rain, and that the percentage of protein may be decreased nearly 8 per cent.

The feeder who has a clear knowledge of the true feeding value of alfalfa hay as compared with timothy and other non-leguminous hays can readily appreciate that it is much wiser to grow alfalfa instead of timothy, and where, for some reason or other, timothy is grown instead, it is only the part of wisdom to market the timothy and invest the proceeds in alfalfa hay or some other leguminous roughage to use for feeding purposes. As a matter of fact, it is the height of folly and an evidence of thoughtlessness for one who is feeding for large and economical production of milk and butterfat to

utilize timothy and other non-leguminous hays in the feeding operations, provided the other feeds grown on the farm and used in feeding the cows are carbonaceous, such as corn, corn silage, corn stover, oats, barley, etc.

Very often the feeder finds opportunity to purchase alfalfa meal in the absence of a supply of alfalfa hay. As a rule, the choicest alfalfa hay grown in the west, where moisture is provided by irrigation, is used for manufacturing alfalfa meal. Where such is the case, alfalfa meal provides a very excellent feed, but the cost of it is much greater than the cost of growing alfalfa or the cost of buying it in baled form shipped in from those sections where it is so largely grown. As a supplement to bran and other protein feeds, however, it is a very advisable food to use for adding mineral matter, protein and bulk to the ration, and, when it can be purchased at a reasonable price mixed with molasses, it adds palatability and proves itself a very useful and advisable foodstuff.

The far-sighted dairyman is the one who provides corn silage and alfalfa hay is a basic ration for his herd. Even though he is compelled to purchase either one or both of these feeds, he cannot afford to be without them.

The 1,000-pound cow that will eat daily 40 pounds of corn silage and 15 pounds of alfalfa hay will secure without other roughage or grain enough nutriment to maintain her body and yield approximately 20 pounds of 4 per cent milk daily. If she is nourishing a foetus, it will be better to consider this a sufficient amount of food for maintaining the cow and producing 15 pounds of milk. For cows yielding more largely it is necessary to feed a less amount of roughage and supplement it with an equally well balanced grain ration in amounts according to her yield.

It is sometimes asked why it is necessary to feed concentrates at all when, by properly combining leguminous hay and corn silage, a balanced ration is provided. It is true that a balanced ration is formulated as far as the proportion of digestible nutrients is concerned, but it is not balanced with regard to the percentage of digestible nutrients in proportion to the indigestible nutrients and moisture. So bulky are corn silage and alfalfa hay, because of the large content of water contained in the former and the large proportion of indigestible material contained in the latter, that a cow producing an extremely large flow of milk does not have sufficient capacity to eat enough of these foods to provide the necessary amount of digestible nutrients for maintaining her own body and manufacturing the milk. Therefore, it is necessary to feed in conjunction with these roughages the proper amount of foods contain-

ing the right proportion of feeding nutrients to stimulate production larger than 15 or 20 pounds of 4 per cent milk daily. However, so much less concentrated and expensive foods are necessary that he who does not avail himself of silage and leguminous hays is not in position to compete with the manufacturer of milk and butterfat who does.

CHAPTER XXIV.

SWEET CLOVER

In a great many respects the most valuable legume is sweet clover. This does not signify that where alfalfa and common clovers can be and are being grown, largely and successfully, sweet clover should be substituted for them, although there are many instances nowadays where farmers, who once believed sweet clover to be one of the most noxious weeds, are growing it in preference to all other legumes.

It is less valuable than alfalfa hay because it is only a biennial and must be re-seeded every other year or permitted to re-seed itself. It does not yield as heavily. It is not as readily eaten by livestock. It makes a hay that is coarse in character, not so readily eaten, and because of its coarse stems far greater waste is experienced in feeding it. A comparison of sweet clover with the common clovers calls forth the same objections to sweet clover except that it yields more largely and does not need to be seeded any more often.

On the other hand, sweet clover possesses many commendable qualities which other legumes do not. In content of feeding nutrients, both in the green state and as hay, it may be considered the equal of alfalfa. Objection is frequently voiced against it by those who have not had experience, and it is condemned by them with the charge that cows will not eat it. There is no logical basis for this charge because experience conclusively proves that all livestock will eat sweet clover in both the green state and as hay, with much avidity, after they have acquired a taste for it. It is true that it has a bitter taste due to the cumarin which it contains, and animals that are well fed refuse to eat it at first.

Instead of this characteristic being altogether objectionable, it has been found to be a point quite in favor of sweet clover when used for grazing purposes. It has been learned that cattle are much less liable to bloat on sweet clover than on any other form of legume. In fact, so few have been the cases of bloat that have occurred from pasturing this legume that there are many who claim that the cumarin eliminates all danger from this source. The few exceptions to this rule indicate, however, that some care should be taken in pasturing valuable cattle on sweet clover when it is wet and the cattle accustomed to it, because bloat caused by it is within the range of possibility.

It is true that cattle must acquire an appetite for sweet clover. This, however, is not sufficient cause for condemning it as a food-

stuff, for the same charge may be made against many other feeds. The steer brought from the range refuses to eat corn when it is first placed before him, and very often a week or ten days is required to teach him that corn is palatable and useful. This is no reason for claiming that corn is not a valuable feed for range steers, but it is quite as reasonable as the claim that sweet clover is not useful for feeding cows.

In the spring sweet clover comes on and grows vigorously before any other crop. It is ready for grazing so early that animals hungry for fresh, green food may be turned on it before any other fresh succulence is available. When this is done, even the most fastidious cow will learn to eat it at once and increase in flow accordingly. After grazing a few days upon it, one will note that the majority of cows prefer it to almost any other kind of green food. Sweet clover is especially valuable for grazing purposes in the hot, dry spells of summer. Being drought-resistant in character, sweet clover grows luxuriantly, even when severe droughts appear, and when all other pastures are dry and worthless the sweet clover pasture provides an abundance of feed, if it has been properly cared for and protected from over-pasturing earlier in the season. It will then be found that all cows will eat it with much relish, and the milk flow which otherwise would diminish so extremely will be held up well throughout the drought period. If sweet clover were used for no other purpose than to provide pasturage early in the spring, during drought seasons and late in the fall, it would be worthy of a place on most dairy farms.

For soiling purposes, sweet clover is valuable because, on account of its rapid and persistent growth, it can be cut often, and provides an abundance of green food from early spring until late fall. When cows have learned to eat it well, there is much doubt if any other crop, except alfalfa, is as valuable for this purpose.

For hay-making, there is but one objection to be lodged against sweet clover and that is rather a serious one. Even though it is cut very young, the stems become hard and brittle when made into hay and are largely wasted because of their unpalatable nature. A limited amount of this hay may be used to advantage by cutting it into quarter-inch lengths, softening it with hot water, steam or diluted molasses and then mixing it with the grain ration. Fed in this manner, a very bulky, palatable ration rich in expensive protein is provided and excellent results can be secured, if from six to ten pounds daily of sweet clover hay is fed.

It is the general belief that sweet clover is a very easy crop to grow, because, as a weed along roadsides, it flourishes as does no

other plant. A most peculiar characteristic of this weed, however, is that it is seldom seen growing on the inside of a fence. This does not indicate that sweet clover is a respecter of fences or that it has any aversion to growing where it is not desired. It does indicate that where the land has been cropped continuously, the condition of the soil is not perfectly suitable for its growth, and that lime and inoculation must be added to the fields, quite as this is necessary for growing alfalfa, before it will grow successfully there. When used for pasture purposes, unless care is taken to prevent them doing so, cattle will eat the sweet clover so close to the ground and keep it so closely cropped that they will kill it. In order to have sweet clover as a part of any pasture, where other grasses are grown, it is necessary to seed it each spring. This shows quite conclusively that when animals have learned to eat sweet clover they will not permit it to re-seed itself even though the other grasses furnish an abundant food.

In conclusion, it may be said that the chief value of sweet clover is that it adapts itself readily to many soils that refuse to grow other legumes, and, by growing it there, the soil undergoes the most excellent preparation that can be provided for making it suitable to grow other legumes later. During the process of this preparation, the sweet clover raised can be used to excellent advantage for pasturage and soiling purposes and in substitution for other roughages and protein feeds when it is made into hay and so prepared that it is rendered edible.

CHAPTER XXV.

CLOVER

Every man who feeds cows knows that clover hay, cut at the right stage of growth, properly cured and well preserved, is the best roughage he can secure for feeding all classes of dairy cattle.

For stimulating large milk production, alfalfa is recognized as superior to clover. For feeding young growing calves, clover is preferable because there is always danger of scours which may be encouraged by the use of alfalfa. Herd sires, dry cows and young heifers that are often fed roughage only for long periods of time will thrive more satisfactorily as a rule on clover than on alfalfa.

In every part of the United States some variety of clover can be grown successfully and it yields abundantly, yet the total acreage amounts to only 2,443,263, or about one-half that devoted to alfalfa, according to the United States Year Book statistics of 1909. Six times as large an area is devoted to the growing of timothy as to the growing of the much more valuable clover crop. To the question of why this is the case there can be but one answer: "It is easier to grow, harvest and store timothy, and men will persist in following the lines of least resistance."

In 1909 there were 19,542,382 acres of land in the United States on which timothy and clover grew together, but the rule is that where this is the case the preponderance of the crop is timothy rather than clover. As a feed for dairy cattle timothy hay is greatly improved by the clover that grows with it, but clover hay is vastly decreased in value by the timothy hay that grows with it. The following table shows conclusively that the mineral matter, the protein and the fat—the most essential nutrients for growth and for stimulating milk production—increase as the percentage of clover increases and the percentage of timothy decreases.

			Digestible Nutrients		
100 pounds	Dry matter	Ash	Protein	Carbohydrates	Fat
Timothy hay	88.4	4.9	3.0	42.8	1.2
Timothy ⅔, clover ⅓	87.9	5.6	4.5	41.7	1.4
Timothy ½, clover ½	87.7	6.0	5.3	41.0	1.5
Timothy ⅓, clover ⅔	87.6	6.4	6.0	40.5	1.6
Clover hay (red)	87.1	7.1	7.6	39.3	1.8

It is the general belief that securing a good stand of clover is difficult and that, even though a stand is secured it may succumb to the rigors of a hard winter. Therefore, it has become customary to

seed timothy with clover so that if the clover fails the timothy will come on and eliminate an entire crop failure. A better way for furnishing dairy roughage with certainty would be to seed the clover alone, observing closely the rules for securing and maintaining a successful stand and then, in event failure results from any cause, re-seed the land with such annuals as oats and field peas, cowpeas, soy beans, sorghum, or other plants that will provide larger tonnages of better roughage for feeding dairy animals than timothy hay.

Another reason for seeding timothy with clover is that timothy, being a perennial, lives long after clover, which is a biennial, ceases to grow, thus giving a more permanent meadow. This is not good reasoning, however, because two years is really long enough for any field, other than those the nature of which render them useful only for pastures, to remain in a single crop where large yields of farm crops and efficient conservation of fertility are, as they should be, the aims in view.

For pasturing purposes, clover ranks well, and at least one variety of this useful legume should be kept growing in every pasture provided for grazing dairy cattle. It is palatable, furnishes abundantly the protein lacking in non-leguminous grasses, furnishes variety and aids the growth of grasses by storing nitrogen in the soil. For these reasons it is well to sow clover seed over permanent pastures each alternate year, or, better, each year, at the time when frost is leaving the ground. There is danger of cattle bloating on clover and, although this danger is less than from alfalfa, cattle should be well fed with dry roughage until such time as they become accustomed to eating the clover, and even then the herd should be frequently observed that the occasional case of bloat which is always liable to occur can be treated before it is too late.

As a soiling crop, clover is second only to alfalfa, and, used for this purpose in conjunction with green alfalfa, it is possible to provide the best of green feed throughout the entire summer without the use of any other soiling crops. By the use of these leguminous green feeds, supplemented with summer silage, cows under comfortable conditions may be kept producing most largely and profitably, provided concentrates are fed in amounts according to the producing ability of the individuals composing the herd.

Like other legumes, clover ensiled makes a silage that is palatable but, because of the strong, disagreeable odor it develops, its use for this purpose is not to be advised. Very often it happens that the second crop is ready to cut at silage filling time and weather conditions make it impossible to cure it into good hay. In such cases it is advisable to ensile it with corn at the rate of one load of clover to

each two loads of green corn. When conditions permit, however, it is more wise to utilize clover for hay-making purposes because cows need dry matter as well as succulence and the silo room is better for preserving other roughage that is more difficult to store in any other way.

Medium red clover is generally grown, and as a rule it is the variety considered, but there are other kinds that under certain conditions and in certain sections are grown instead.

Alsike clover is preferable for wet land and will grow on soils more acid than will red clover, but, because of its weak stems and its consequent tendency to lodge, it is not often used where red clover can be successfully grown.

Mammoth clover gives a much larger yield than red clover, but, because it grows so rank and develops such coarse stems, it is less palatable to cattle, and the result is much more waste in feeding. This objection may be partially overcome by pasturing it early in the spring and permitting it to mature later when weather conditions are less conducive to extensive growth.

In the far eastern states, crimson clover seems to thrive better than other varieties and it provides excellent roughage when cut at the right stage, which is just prior to the time when the small, prickly hairs of the blossoms and of the stems begin to harden and become wiry.

In the southern states, burr clover is recognized as a very valuable supplement to pasture grasses, and in many sections of the south, where it is once introduced into pastures, it continues year after year to make its appearance. Because of its low-growing nature, it is not often used for soiling or for hay making.

In the western coast states, recently, a clover termed Eureka has come into considerable prominence and because it yields so largely and provides very palatable protein roughage, it promises to become prevalently grown and very useful to dairymen in that section.

The accompanying comparison of the feeding values of the several most important varieties of clovers, compiled from Henry and Morrison's "Feeds and Feeding," illustrates their worth to the dairyman:

100 pounds	Dry matter
1. Clover (Medium Red)	87.1
2. Clover (Alsike)	87.7
3. Clover (Crimson)	89.4
4. Clover (Mammoth)	81.3
5. Clover (Burr)	93.0
6. Clover (Sweet-White)	91.4
7. Clover (Sweet-Yellow)	91.3

		Digestible Nutrients		
	Ash	Protein	Carbo-hydrates	Fat
1.	7.1	7.6	39.3	1.8
2.	8.3	7.9	36.9	1.1
3.	8.8	9.7	36.8	1.0
4.	6.2	6.4	37.2	1.8
5.	10.8	15.6	42.8	0.2
6.	7.2	10.9	38.2	0.7
7.	6.0	10.0	35.9	0.5

A comparison of the feeding value of the various clovers with the more commonly grown non-leguminous forage plants should show in an impressive manner the advisability of growing clover or other legumes for the purpose of supplying mineral matter and protein in the cow's ration with home-grown feeds and in the cheapest manner. Such a comparison even indicates that if one raises roughages that are low in these important nutrients it would be but the part of good business to sell them and invest the money in leguminous roughages. To secure large and profitable milk production and acceptable growth in young animals, protein and ash in certain well defined amounts are absolutely necessary. If they are not grown in grasses or grains, then they must be purchased through the feed dealer in by-product feeds, grains or leguminous hays.

CHAPTER XXVI.

SOY BEANS

For more than a century soy beans have been successfully grown in China and Japan. So rich are the seeds of the plant in protein and fat that they are there largely used as human food, and of late years vast tonnages have been brought to our western coast states where the use of soy beans as a food for livestock has opened a steady market. For the past 20 years soy beans have been grown in the southern and western parts of the United States. Although in many instances they have been raised to maturity for grain and seed purposes, they are generally grown for silage and forage purposes.

There are certain characteristics possessed by this leguminous plant which insure a more extensive use of it among dairy farmers who strive to raise on the farm as large a portion as possible of the feed required by their animals. As a substitute for clover and alfalfa the soy bean is especially valuable, because late in the spring when it has been learned that the clover seeding is a failure, enough time remains to seed and grow a crop of soy beans, which, if harvested as soon as the pods begin to form, provide excellent roughage containing a larger per cent of protein than alfalfa hay and much more than clover. This is especially true if carefully harvested to avoid losing the leaves which contain more nutriment than the stems. The one objection to soy beans as a hay crop is the coarseness and woodiness of the stem. This can be overcome, however, by proper seeding.

As a crop for the silo the soy bean has not proven altogether satisfactory where used as the sole crop. At the Wisconsin Experiment Station many experiments have been conducted, and the results indicated that corn silage or silage made from a mixture of corn and soy beans was much more advisable for several reasons. Most of the cows did not relish the soy bean silage as well as that made from corn, and some of them absolutely refused to eat of the soy bean silage, making it necessary to substitute hay and concentrated foods. Less tonnage of nutriment was obtained from an acre of soy beans than from an acre of corn; the former yielded 16,950 pounds; the latter 30,400 pounds. As is the case with silage made from most leguminous crops, an odor developed that was disagreeable for cow and man alike. There was a waste of soy bean stems and the cows decreased in milk flow. In addition to these objections it was found that soy bean silage had a detrimental effect upon the quality of milk, butter and cheese.

This latter objection was very noticeable. It was further found at the same station that these objections did not apply to silage made from corn and soy beans mixed. The mixed silage was eaten with relish, and no deleterious effects were noticed in the quality of milk or cream yielded. As a matter of fact, many experiment stations recommend very highly the use of soy beans for the purpose of supplementing and adding protein to corn silage. Where the soy beans and corn are grown separately, it is usually advised that one ton of soy beans be placed in the silo with two tons of green corn.

Although it is usually recommended that soy beans be grown separately for making corn-soy bean silage, it is possible to raise them together. By the use of a separate attachment on the corn planter the beans may be planted at the same time. Where corn is drilled in, it may be planted first and with smaller plates in the planter box the soy beans may be drilled in the same rows at a depth of from one to two inches. On fertile soil they grow upright and by the time the corn is ready to harvest the plants are between three and four feet high, so that, by the use of the corn binder, they may be readily harvested with the corn.

Silage made from the crop grown in this manner is much richer in protein than common corn silage and much more stimulating to milk production. Even as far north as Iowa and southern Minnesota this plan is an advisable one.

In climates where soy beans may be raised to maturity and the seeds harvested, they have proved a very profitable crop, there being always a large demand. The yield varies, according to the character of the land and the climatic conditions, from 10 to 30 bushels per acre, and they sell readily for from \$1.50 to \$2 per bushel.

It is only this high price which prohibits their use for feeding farm animals, because their feeding value approaches very closely that of oil meal.

As a soiling crop, soy beans provide a large tonnage of very palatable green feed but, because it is necessary to seed them rather late in the spring after the soil has become thoroughly warm, they do not provide soiling until about the middle of August.

They yield from five to ten tons of green feed per acre and, because of their richness in protein, they are excellent for feed, and their power to resist heat and drouth makes them a comparatively sure crop. They provide good pastures before cutting, but if the crop is cut for hay or silage little pasturage is secured afterwards. Under favorable conditions early varieties of soy beans will mature in from 90 to 100 days.

The Ohio Experiment Station recommends as the most advisable variety to grow in the northern latitude the medium green, the only objection to it being that, if allowed to ripen, the seeds shatter off and are wasted. The Ito San variety is presumed to be the second best, but does not yield so heavily of forage for roughage purposes. The medium yellow produces about the same amount of seed and an amount of forage between that of the former varieties. Other varieties mature later, and is not advisable to grow them except for late green feed and for plowing under to replenish the fertility of the soil.

It is generally known that the richer the soil and the more favorable the climate the greater the yield of forage, though not necessarily a greater yield of seed. Throughout the corn belt soy beans will grow luxuriantly. In seeding, the bed should be prepared much as for corn. Being a warm-weather plant, soy beans should not be planted until all danger of frost is past and then it is more advisable to drill, placing the seeds at a depth of one or two inches, than to broadcast. If the crop is to be grown for seed, the rows should be from 24 to 30 inches apart, but if grown for hay or soiling, the rows should be much closer to insure finer quality.

A common grain drill may be used for seeding. It may be set to seed from one and one-half to two bushels of seed per acre where it is to be used for green feed or hay, but where planted for growing seed or making silage, from two to four pecks per acre will be sufficient. When planted in rows the cultivation may be much the same as for corn, but where the seeding is solid the plants must be left to take care of themselves after they have come through the ground.

To secure the greatest value from the plant for hay-making purposes it should be cut and cured as soon as the pods begin to form. If allowed to remain growing longer the stems become woody and the leaves and grain begin to fall. In humid climates it is rather difficult to cure. It is advisable to cut with a mower in the morning after the dew has left the plant, allowing the swaths to remain for two or three days, when the hay should be raked up in windrows, cocked and allowed to stand for several days until cured sufficiently so that no water can be wrung from the stems when twisted in the hands. The plants will stand a considerable amount of rain after cutting without becoming completely spoiled. They are harvested in much the same manner for threshing, except that they are allowed to remain growing in the field.

CHAPTER XXVII.

COWPEAS

Cowpeas, as well as soy beans, are more largely grown in the southern states than farther north, so that from the experiment stations of these sections more information is derived. The University of Tennessee is authority for the following facts: "The soy bean may be advantageously sown earlier as well as later in the season than the cowpea. Germination and thrifty growth should follow in weather too cool for the cowpea, which should not be sown until warm weather is fully established or, in this latitude, from the middle to the last of May. Light frosts, which are sufficient to kill cowpeas and other tender plants, do not affect soy beans either when young or old. The best early varieties when planted in April mature their seed about six weeks earlier than the Whippoorwill cowpea, a matter of special importance in pasturing. A stand of cowpeas is more certain than a stand of soy beans. This is due chiefly to two causes: (1) Soy beans may fail to come up through a soil crust which would offer little resistance to cowpeas; (2) the germination of the cowpea seed is surer than that of the soy bean seed, which is liable to be spoiled by heating. The cowpea is, therefore, superior for seeding broadcast, especially on land which is heavy and apt to 'bake' or which has been poorly prepared.

"The cowpea is much better suited than the soy bean for planting either with sorghum or corn whether for forage or for soil improvement purposes. According to the station's trials the standard bush pea, the Whippoorwill, is a good climber when planted with corn for silage, and under such conditions outyields in both vine and fruit any variety of soy beans.

"Cowpea hay is more easily cured by the methods in common use, without excessive loss of either leaves or fruit, than soy bean hay.

"A second growth, which sometimes amounts to a fair crop, may be obtained from cowpeas after they are cut for hay, but not from soy beans.

"The important conditions under which the cowpea is preferable to the soy bean are (1) when planted with either corn or sorghum; and (2) for seeding broadcast, under the present average farm conditions. The soy bean, on the other hand, appears more valuable than the cowpea (1) as a grain producer, whether to be pastured off or to be threshed and ground for general feeding purposes;

(2) as an intensive farm crop, desirable where the best methods of farming are practiced, in which case it may be grown to advantage either early or late in the season for both hay and grain, and may be used incidentally as an especially good cleansing crop, because cultivations can easily be continued until the ground is well shaded; and (3) as an early hay or grain crop, for which purpose the early and medium varieties will produce either hay or seed several weeks ahead of any variety of cowpeas which has been tested at the station."

In northern climates early varieties of cowpeas must be selected, and chief among these are the Whippoorwills and the New Eras, each of which will produce largely of green feed and forage but, as a rule, do not mature for threshing a grain crop. Both cowpeas and soy beans being such luxuriant growers, yielding in the neighborhood of 20,000 pounds of green food, 3,000 pounds of dry substance and about 500 pounds of protein per acre, a trial of a few acres at least should be made. In addition to the above values, the fact that they replenish soil fertility will make them well worth considering in rotating crops.

Canada Field Peas

In the northern latitudes, a crop equally advisable and one which will meet with more favor is the Canada field pea. This crop is very extensively grown in Canada. It is not uncommon to obtain yields varying from 20 to 40 bushels per acre. These peas are very rich in protein, containing about 16.8 per cent in a digestible form. To provide a forage crop Canada peas are usually sown with oats at the rate of about a bushel and a half each per acre or, what may be more advisable, about seven pecks of peas and about five pecks of oats. Canada peas stand cold weather and frost admirably so that, in order to give them an excellent start, they should be drilled two or three inches deep as early as possible in the spring. Later the oats may be broadcast and harrowed in. This gives the peas an opportunity to mature to a greater extent than where the oats and peas are seeded at the same time. Like oats, the Canada pea is a rapid grower,

			Digestible Nutrients		
	Pounds Dry Matter	Pounds Ash	Pounds Protein	Carbo-hydrates	Fat
Corn silage	26.3	1.7	1.1	15.0	0.7
Corn and clover silage	28.6	2.2	2.1	15.9	0.7
Corn and soy bean silage	24.7	2.0	1.6	13.8	0.8
Oat and pea silage	27.5	2.8	2.8	12.6	1.0
Sorghum and cowpea silage	32.3	2.2	0.9	16.6	0.6
Alfalfa hay	91.4	8.6	10.6	39.0	0.9
Cowpea hay	90.3	11.9	13.1	33.7	1.0
Soy bean hay	91.4	8.6	11.7	39.2	1.2
Field pea hay	88.9	7.9	12.2	40.1	1.9
Oat and pea hay	83.4	7.3	8.3	37.1	1.5

and by seeding the latter part of March the crop is ready to harvest the latter part of June of the first of July. By successive seedings, oats and peas may be seeded up to the middle of May or the first of June, providing green feed throughout the summer.

That portion of the crop which is not used for soiling may be harvested at the time the oats are in the dough stage and an excellent quality of hay is easily cured. Hay made from Canada peas and oats sown as suggested is almost as valuable for feeding dairy cows and other farm animals as clover hay. The yield per acre varies from 15,000 to 25,000 pounds of green food; from a ton to a ton and a half of dry hay and from 300 to 500 pounds of digestible protein. The most serious objection that may be lodged against the Canada pea is that it does not stand hot or dry weather as well as do either cowpeas or soy beans. In latitudes north of the middle of Iowa early seedings may be well matured before severe drouths occur, and in all likelihood oats and Canada peas will prove the most desirable substitute where the clover crop is lost. South of this latitude, the cowpea and soy bean will take precedence. In southern Illinois, where fall wheat is largely grown, the practice is often followed of breaking up the ground after harvesting the wheat, seeding to cowpeas and securing from a ton to a ton and a half of excellent hay during the late summer months. Illustrative of the value of these leguminous hays and the seeds from them as compared with other farm crops and commercial feeds with which the readers are most familiar, the table on the preceding page shows the dry matter, ash and digestible nutrients in 100 pounds of these different feeds.

CHAPTER XXVIII.

OTHER LEGUMINOUS ROUGHAGES

Vetches

In addition to the legumes that are so commonly known, there are a few that can be raised in certain sections to advantage because of soil and climatic conditions. Although these are not of general importance, the value of them should be known and recognized by those who should grow and use them. Chief among these are the vetches. There are many varieties but only two that are especially useful as roughages for dairy cattle in this country.

Common Vetch

The common vetch is an annual much like the garden pea. Its stems are more slender and taller, usually growing from three to five feet high. The flowers are violet purple as a rule, but sometimes white. The pods which bear four or five grey seeds, are brown and at maturity they readily coil and discharge the seed.

There are both spring and summer strains of common vetch. The winter variety is largely grown in western Oregon where it is usually sown in the fall and it is now known as Oregon winter vetch.

On the western coast, common vetch is grown to a large extent as a winter crop with oats, barley or wheat for hay and pasturage. It is useful only in mild climates, for it does not stand the hot, humid summers nor cold winters. A temperature below 10 degrees Fahrenheit causes winter killing of common vetch. Its use, therefore, is limited to the western coast and southern states. In these sections it thrives on well drained land and is often used in the fruit districts of southern California as a soil improver, for, like other legumes, it has the power of transferring nitrogen from the air to the soil.

If sown alone common vetch should be broadcast or drilled on a well prepared, firm seedbed at the rate of one bushel of seed per acre. Where seeded with oats, as is most advisable for grazing or haymaking purposes, one-half bushel of vetch seed sown with 20 pounds of oats will provide a suitable stand, although on extra good land it is common practice to seed as high as 60 pounds of vetch seed and 40 pounds of oats. For winter grazing and early soilage common vetch is sown in September and October. If it is not grazed during the winter it is ready to feed about the first of May and may be cut for hay by the first of June. It may be sown in February or March and is then ready to cut by the middle of June or the first of

July. Common vetch is one of the most useful legumes that can be raised in the west and in the southern states for winter grazing and for early spring feed, and is especially valuable for this purpose where seeded with oats.

In some sections common vetch seems to become naturally inoculated, but where it has not been previously grown it is as necessary to inoculate for it as for any other legumes. Unless inoculation is practiced, by transferring soil from a field that has successfully grown vetches or by treating the seeds with commercial culture, failure in securing and maintaining a stand will likely result.

Hairy Vetch

Hairy vetch, also known as sand vetch, Russian vetch, Siberian and Hungarian vetch, differs from the common vetch in that it is a biennial if planted in the spring and is a much hardier variety. Its flowers are white and its seeds, which are only half as large as the seeds of common vetch, are nearly black and shatter much more readily than those of common vetch. Hairy vetch grows wherever common vetch does and withstands the winters in every section of the United States, thriving as far north as Michigan, New York and even the New England states. Its hardiness is increased by the use of home-grown seed. It grows well on sandy soil, resists drouth and grows on soil that is too alkaline for other legumes.

Where there is sufficient moisture in the fall, it should be sown at that season unless it is desired to keep the crop on the same land for two seasons, then the seeding must be done in the spring in the northern states. It is not advisable to seed in the spring farther south because hairy vetch, like common vetch, does not resist severe summer heat. Fall wheat and rye with which 25 pounds of hairy vetch seed are an excellent grain combination to seed in the fall to the extent of providing a light stand.

Like common vetch and other legumes, inoculation is necessary when the first attempt is made to grow these plants. This, however, should not interfere with the growing of legumes, because the problem of inoculating one field with soil from another field that has grown the legume desired is a simple task. Where soil from such a field cannot be secured, inoculating with commercial artificial culture is inexpensive and not difficult to perform.

Most of the hairy vetch seed used in this country in the past has been obtained from Russia. The high cost of vetch seed is the principal reason why vetches are not more largely grown. However, even though the seed costs from 3 to 7c per pound in normal times at European ports, nearly a half million pounds are imported by this

country annually. It is possible to mature vetches and harvest the seed in this country, the average yield of common vetch seed being approximately 12 bushels and of the hairy vetch seed about 5 bushels, although yields as high as 11 bushels per acre have been known.

Hairy vetch is adapted to nearly as wide a range of use as red clover, and where for any reason red clover does not succeed it is an excellent substitute. It furnishes excellent pasturage and may be grazed in the spring without materially reducing its yield as a hay crop. It is difficult to harvest for hay unless seeded with upstanding crops, but when, like common vetch, it is cut when the first pods have formed, it furnishes protein in a most desirable form. Like other legumes, it is a little difficult to cure unless hay caps are provided so that it may be cured in the shock. On good land vetches provide some pasturage and a yield of from 1½ to 3 tons of hay per acre. In the Pacific states it is estimated that the crop will yield an average of 2½ tons while in the southern states the estimate is somewhat smaller.

It should not be understood that vetches are advised as substitutes for clover and alfalfa, but where conditions are such that these useful legumes cannot be raised successfully vetches should be raised, because on every dairy farm, in whatever section of the United States it may be located, some leguminous crops should be raised for furnishing protein by an economical method for the dairy cows' rations and also because of their power to build up soil fertility.

Illustrative of the value of vetches, both common and hairy, the accompanying table giving the content of ash and digestible nutriment shows them to be even more valuable than clover and alfalfa hay for feeding with carbonaceous foodstuffs:

			Digestible Nutrients		
100 pounds	Dry matter	Ash	Protein	Carbo-hydrates	Fat
Vetch (common)	92.9	8.2	11.6	42.8	1.6
Vetch (hairy)	87.7	8.6	15.7	37.1	1.9

CHAPTER XXIX.

OTHER LEGUMINOUS ROUGHAGES

Lespedeza

A nitrogen gathering plant which has become very popular as well as extremely useful throughout the entire south is lespedeza or Japan clover. It is an annual plant that is believed by many to be a perennial because, unless it is very closely grazed, it reseeds itself from year to year so that once it has been made a part of the pasture or meadow it continues to grow.

Even on the poorer soils of the south, lespedeza thrives sufficiently well for grazing purposes, and on the richer soils grows tall enough for hay and sometimes yields as high as three tons per acre. As a pasturage crop it is superior to red clover or alfalfa in that it is not so prolific a source of bloat, although instances have been known where it has caused cattle to bloat; so for this reason care should be exercised in turning cows onto it when it is wet or when the cows have not been accustomed to grazing on it.

Very often lespedeza hay is found on the southern markets and on southern farms, which is not especially good for feeding purposes. It is not very palatable to livestock because of its stemmy character and the limited amount of leaves. This, however, is not so much a fault of the plant as it is of the manner in which it has been harvested. Like all other crops which are made into hay, lespedeza should be cut before it has reached that stage of maturity where the leaves are shed, and, like other legumes, it should be cured in the shade. The best method of doing this is to shock it up as soon as possible after it has been cut and, by protecting it from the elements with hay caps, permit it to cure in such a manner that the leaves—the most valuable portion of the plant—are retained.

The chemical analysis of lespedeza shows 100 pounds of the hay to contain 88.2 pounds of dry matter, which consists of 5.8 pounds of mineral matter, 8.6 pounds of protein, 41.1 pounds of carbohydrates and 1.1 pounds of fat. Therefore, if the hay is harvested and cured in such a manner that it is palatable, lespedeza may be considered the equal of red clover hay. There are many southern dairymen who contend that it is at least equal in feeding value to alfalfa hay.

Velvet Bean

Another leguminous plant that flourishes in the south and promises to become an excellent source of pasturage, soiling crops and concentrates is the velvet bean. Because it is a tropical plant it

cannot be raised successfully north of Arkansas. The velvet bean plant makes tremendous growth; its stems running along the ground to a length of from 20 to 60 feet. Because it does not grow upright it is very difficult to make it into hay, but in some instances where the beans have been harvested yields of 30 bushels weighing 60 pounds to the bushel have been secured.

A good stand of velvet beans will furnish throughout the summer months sufficient grazing to feed well at least one cow to the acre, and where sufficient labor is exercised to make hay out of the crop a roughage is provided which is extremely high in feeding value. One hundred pounds of such hay contains 92.8 pounds of dry matter in which there is 7.4 pounds of mineral matter, 12 pounds of digestible protein, 40 pounds of carbohydrates and 14 pounds of fat.

Some southern dairymen are now gathering the seed pods and storing them for feeding purposes. These are not only palatable, but, containing 87.7 pounds of dry matter per hundredweight, which consists of 4 pounds of mineral matter, 14.9 pounds of digestible protein, 51.7 pounds of carbohydrates and 3.8 pounds of fat, a feed of much value is furnished and may be used in substitution for cottonseed meal and other high priced nitrogenous foods. When the pods are threshed beans are liberated that have a feeding value even higher, as they contain 18 per cent of digestible protein and over 5 per cent of fat. In those states where the velvet bean grows successfully it is to be highly recommended as a source of pasturage and for providing a concentrated feed in the form of seeds and pods. Considering the labor and expense required to separate the seeds from the pods, it will likely prove more profitable to feed the pods without threshing them, especially in view of the fact that a less concentrated and more bulky food is furnished than though the seeds alone were used.

Peanuts

Large acreages of peanuts are raised in the south. In fact, after the demand for peanuts for commercial purposes is filled, large acreages remain for stock-feeding purposes. The peanut vine thrives so luxuriantly in the south and furnishes digestible protein and fat in such abundance that there is much of the land that may well be devoted to the raising of this crop for economically furnishing these nutrients to feed with carbonaceous foodstuffs. As a rule, peanuts are raised more largely for hogs than for cattle. When they have matured sufficiently the hogs are turned in the fields to harvest the crop. They eat the vines, root out the peanuts, eat them also, and thrive. The table on the next page compiled from Henry and Morrison's "Feeds and Feeding" shows in a conclusive manner the exceptional feeding value of the peanut vine and its product. Even the

vines after the nuts have been removed from them have a feeding value that compares favorably with clover hay. If these vines are preserved in such a maner that they are palatable, they should prove useful indeed for furnishing a portion of the roughage for the dairy cow's ration.

Where the peanut vines are harvested with the nuts, as they often are in the south, a food is provided that is palatable and is the equal of alfalfa hay.

Were it an economical process to feed peanuts without hulls it would be advisable to feed them in very limited amounts with other foodstuffs rich in carbohydrates because, as shown by the table, peanuts are extremely rich in protein and fat. Where fed in abundance and not properly balanced with other feeds, digestive troubles would result. This same thing would be true to a lesser degree were peanuts with the hulls ground and fed, because of their large content of digestible fat, which is 32.6 pounds per hundredweight.

A most desirable feed to use as a concentrate would be the peanut cake resulting after the oil has been extracted from either the hulled or unhulled nuts, because of the large content of digestible protein and the favorable content of digestible fat which remains.

The nutriment contained in the hulls alone is not great, so, in case they are used at all, mixed with other foods to make them palatable, it should be for the purpose of furnishing bulk to the ration even as ground corn cobs are so largely used for that purpose in the corn belt.

It is not probable that peanut vines or the products of them will ever become sufficiently plentiful so, in a general way, the problem of using them will present itself to the rank and file of dairy cattle feeders; but so great, from the standpoint of chemical analysis, is their feeding value that the dairyman of the south should plan to use them when they are available at a price within reason. By knowing the true feeding value of them he can fit them into his dairy ration in such a way as to secure from them the nutrients that will stimulate large milk production.

			Digestible Nutrients		
100 pounds	Dry matter	Ash	Protein	Carbo-hydrates	Fat
Peanuts (without hulls)	94.0	2.2	24.1	14.9	40.4
Peanuts (with hulls)	93.5	4.1	18.4	15.3	32.6
Peanut waste	96.0	5.4	22.0	22.9	30.1
Peanut cake (from hulled nuts)	89.3	4.9	42.1	20.4	7.2
Peanut cake (hulls included)	94.4	4.5	20.2	16.0	10.0
Peanut hulls	90.9	5.5	0.4	33.0	2.1
Peanut vines (with nuts)	92.2	6.8	9.6	39.6	8.3
Peanut vines (without nuts)	78.5	8.7	6.6	37.0	3.0

CHAPTER XXX.

MISCELLANEOUS FEEDS

There are many feeds of great importance that at certain seasons of the year and in certain localities present themselves for consideration to the one who feeds for large production, which he attempts to secure as economically as possible. Because such feeds are not available at all seasons of the year, nor at any season of the year in all localities, they are not generally considered and as a rule the feeder does not recognize the value they represent even when, perchance, they become available. If he did, he could well afford to use them for reinforcing his rations, increasing production and decreasing expense. For these reasons such feeds will be discussed briefly in this and the following two or three articles, prior to the chapters dealing with combining the various feeds by methods that tend to formulate the most suitable rations for various classes of animals and the various purposes for which dairy cattle are fed.

Molasses

There are two kinds of molasses available in nearly every section for feeding purposes, sugar beet and cane. In close proximity to sugar beet factories the molasses which remains as a by-product in the manufacture of sugar can often be secured at a price low enough to render its use in limited amounts advisable. In Europe where other carbonaceous feeds are more expensive than in America, molasses, which is termed treacle, is used very extensively not only because of the food value it represents but also for the purpose of rendering other foods not palatable to livestock useful for feeding purposes. Although beet molasses and cane molasses have practically the same chemical analysis, except that beet molasses runs higher in protein, the cane molasses is considered more valuable because it is less laxative.

There is no form of feed that is more palatable to most classes of livestock than molasses. It is for this reason that as other foodstuffs increase in cost, as they have been increasing during recent years, molasses will come more into favor by all feeders because they will choose to utilize much of the unpalatable roughage that now goes to waste. Dry corn stover, straws resulting from the growing of various grains, sweet clover hay and other such feeds which animals do not eat with avidity when fed alone can be used in large quantities by moistening them with molasses diluted with water. By using two or three pounds of molasses daily per cow in this manner,

large volumes of roughage that would otherwise be wasted can be utilized to excellent advantage for furnishing roughage where feeders are careful to supplement such roughage with concentrates that will balance the ration and provide for the cow suitable nutrients in abundance for stimulating her normal flow of milk and butterfat.

Furthermore, there are many concentrates that cows do not eat readily, even though chemical analysis demonstrates that they are of high feeding value. At the present time these feeds, cheap in price, are discriminated against by the feeder for no other reason than that they are not readily eaten. Were the same feeders to judiciously use molasses, which in normal times can be secured at reasonable prices, such feeds could be made useful to excellent advantage.

Molasses does have objections to its use. Chief among these is that, unless provision is made for a systematic use of it, the task of mixing it with rations is a disagreeable one. Where it is used in the summer time flies are attracted to the barn in large numbers and additional precautions must be taken for eliminating them. Unless care is used to obviate overfeeding molasses, it is certain to cause scours in young animals and is very liable to have such effect upon animals that are mature. When fed in amounts not exceeding three pounds daily per thousand pounds live weight to older animals an over-laxative condition seldom appears—never except with individual animals, and to these the thoughtful feeder will give a smaller daily supply.

Very often molasses is used in small quantities for fitting cattle for exhibition and sale purposes. By stimulating the appetite an animal is influenced to eat more heartily of other foods and thereby caused to gain rapidly in flesh and condition. It is generally believed among practical feeders that molasses has a tendency to soften the hide and make silken the hair of animals and, as such a condition gives a more pleasing appearance and hastens the operation of bringing animals into bloom, those who feed cattle for exhibition and sale purposes are quite partial to the use of both beet and cane molasses.

Molasses is an easily digested feed, being soluble in water, provided it is fed in small amounts, but, according to Dr. Lindsey of the Massachusetts Experiment Station, it is likely to affect adversely the heart and kidneys if fed in excess and to appear undigested in the urine. After making numerous experiments, Dr. Lindsey refutes the idea so generally accepted by practical feeders that molasses aids the digestion of other foods. He says: "It may be stated that while molasses is completely digested, it does not improve the

digestibility of the feedstuffs with which it is fed, but actually causes them to be less digestible (average about eight per cent.) This does not mean that molasses is without value as a food. An entire ration, of which molasses is a component, would be rather more digestible than the ration without molasses, for the reason that, although the molasses depresses the digestibility of other components, its entire digestibility more than makes up for the action as a depresser of digestion. It is not advisable under usual conditions to feed a ration containing a total of more than 15 per cent of molasses."

According to chemical analysis molasses is three-fourths the equal of corn meal in feeding value, with the exception that cane molasses contains slightly less protein, more water and more ash. Furthermore, the carbohydrates in both beet and cane molasses are in the form of sugar rather than starch.

In actual feeding value the practical feeder who has used molasses judiciously gains the impression that it is at least equal in value to corn meal, but those who have experimented scientifically in an attempt to determine definitely the relative feeding value of molasses differ in their conclusions. After experimenting largely Dr. Lindsey summarizes his results as follows:

"1. Any particularly favorable effect of Porto Rico molasses upon the general health and appearance of the six milch cows employed in the * * * experiment was not observed. The faeces from the molasses fed animals were darker in color and softer than those receiving the corn meal ration.

"2. A daily ration containing nearly four pounds of corn meal produced some 10 per cent more milk and 11 to 13 per cent more total solids and fat than a similar basal ration containing a like amount of Porto Rico molasses.

"3. The molasses ration seemed to produce milk with slightly less fat and solids not fat than did the corn meal ration.

"4. A like amount of milk and butterfat from the molasses ration cost 8 to 11 per cent more than from the corn meal ration.

"5. Molasses did not provide any unfavorable effect upon the flavor of the milk."

After summarizing in this manner Dr. Lindsey quotes from European experiments as follows:

"Numerous foreign experiments are recorded relative to the value of both raw molasses and of molasses feeds for milch cows. The results are often contradictory; in some cases it is indicated that molasses increased the fat percentage in the milk, and in other cases the body weight.

"The general conclusions at the Copenhagen Experiment Station, where experiments were conducted according to the Fjord method, were that corn, wheat, wheat bran and also molasses had substantially equal values for dairy stock but that for milk production these were inferior to concentrated feeds rich in protein and fat. A molasses ration did not cause any marked change either in the condition of the animal or in the quality of the milk. It had no effect on the composition of the butterfat other than to increase the melting point some two degrees and render the butter firmer.

"Ramm's investigation led him to conclude that the amido bodies contained in the molasses act as a stimulant upon the mammary glands and check the normal diminution in the secretion of the milk. Both Ramm and Hagermann further maintain that the organic matter other than sugar in the molasses increases the fat percentage and the butter-producing quality of the milk.

"P. Hoppe demonstrates that the addition of small quantities of molasses (two pounds daily per 1,000 pounds live weight) causes a small increase in the daily milk production, but that the yield is noticeably decreased when the amount supplied daily reaches four pounds per 1,000 pounds live weight. Contrary to Ramm and Hagermann, Hoppe notes a decrease in the fat percentage of the milk. He further concludes that an intensive molasses diet is not suitable either for dairy animals or for any other farm stock."

In a way, these results, which are more or less conflicting, leave the reader to decide for himself the advisability of utilizing molasses for feeding purposes. Due consideration will probably bring him to the conclusion that whenever it is possible to secure molasses at a price less than corn or other carbonaceous foods, he can use the treacle to advantage. Even in instances where it is somewhat more expensive than other carbonaceous foods, he will decide to use it in limited amounts for adding palatability to other foodstuffs for cheapening the ration, and also he will desire to use it for special purposes, such as fitting animals quickly and efficiently for the sale ring and showyard. He should be impressed with the fact that he should not use more than three pounds daily per 1,000 pounds live weight, and, if he confines himself to two pounds per 1,000 pounds of live weight, he will without doubt find molasses more useful in his feeding operations.

So digestible is molasses that one might be led to believe that it would be especially valuable for feeding young calves. This seems, however, not to be the case. At the Louisiana Experiment Station, which is located in that section where blackstrap cane molasses is abundantly available for feeding purposes, experiments

were made by T. E. Woodward and J. G. Lee. They describe the manner in which the experiments were performed and draw their conclusions as follows:

"The young calves were kept in individual pens 4x6. Part of the time they were allowed to run at will in a lot during the day, but were placed in their pens at night. The pens were cleaned out twice daily and the young animals bedded with sawdust. Kreso (a coal tar preparation) was rubbed or sprayed on the calves to keep them free from ticks and consequent irritation. The older calves ran out in pasture with the cows during the day, and at night were fed in their individual stalls.

"Thirteen calves in all were fed blackstrap molasses. The young calves received from four to six pounds of skim-milk twice daily; the object being to underfeed, rather than overfeed them. The older calves received six to eight pounds of skim-milk twice daily. These would have been fed more but for the fact that this amount was all to which they had previously been accustomed.

"The young calves were given all the hay and grain they would clean up; the older ones received about two pounds of grain daily. The grain consisted of two parts bran, two parts corn meal, and one part oil meal. The only available roughage was oat hay and crab-grass hay.

"In no instance did the molasses fail to scour the calves. The amount required to produce scours varied all the way from one-twentieth of a pound in the case of very young calves, to seven-tenths of a pound in the case of the seven-months-old calves.

"The molasses first used was slightly sour. Fresh molasses was, however, secured and heated to a temperature of 180 degrees Fahrenheit, or more, but still the scouring continued. Pasteurization of the skim-milk did not have any beneficial effect. Exercise seemed to make no difference, so far as the condition of the calves' bowels was concerned. Granulated sugar produced the same results as an equivalent amount of sugar contained in the molasses. Milk sugar proved laxative also, but about twice as much of it can be fed; in other words, two ounces of milk sugar has the same effect as one ounce of cane sugar. When the calves scoured, their droppings were sour-smelling; but when they did not scour, their droppings did not smell sour.

"Several substances were fed along with the milk and molasses in the hope of finding something that would prevent scouring: Formalin, blood meal and lime water proved useless. Common salt (na cl) had a slightly beneficial effect. Fifty grains of tannin in some cases enabled us to feed about one-half more molasses than it

was possible to feed without it; in other cases it seemed to be without effect. All of the substances mentioned, as well as the sugar and molasses, were fed mixed in the milk.

Conclusions

"On account of its laxative effect blackstrap molasses can not be used as supplement to skim-milk for calf feeding purposes in sufficient quantity to be of any practical value.

"This laxative effect is due to the sugar content, rather than to any of the other constituents of the blackstrap.

"Scouring is caused by the fermentation of the sugar in the digestive tract.

"Salt and tannin have a beneficial effect, but will not prevent scouring."

Molasses Feeds

There are numerous valuable molasses feeds upon the market and many of these are very useful for feeding purposes. On the other hand, there are some molasses feeds that are not to be recommended because they are largely made up of materials quite the same in character as much that is being wasted upon the farm. By grinding such materials low in feeding value and palatability and mixing them with molasses, they are rendered palatable and therefore salable.

In purchasing molasses feeds one should observe the chemical analysis which appears on the bags or tags attached to the sacks in states where laws require the manufacturer to label the feed with its true analysis. If molasses feeds showing large digestible feeding values are available at reasonable prices, they are excellent to use for adding palatability and food value to the regular ration, and they eliminate the disagreeable task of mixing molasses with rations that are formulated at home.

The chief merits of a feed are that it contains proper feeding nutrients in a digestible form, that it is palatable and inexpensive, and that it adds variety to the ration, so I do not hesitate to recommend to feeders that they use molasses feeds which are offered them, provided investigation shows these requirements have been fulfilled by the manufacturer. On the other hand, I do not hesitate to warn feeders that they discriminate against molasses feeds which do not show that they meet these requirements. In many sections alfalfa and molasses can be secured at very reasonable prices, and in such instances, where the feeder has a right to believe that the alfalfa which was ground before mixing the molasses with it was of good quality, he can well afford to make use of the feed because, alfalfa being high in digestible protein and molasses being high in carbohydrates, a ration more nearly balanced than though molasses were fed by itself will be secured.

Pumpkins

There are very few sections where pumpkins will not grow. In fact, they seem to thrive in most climates and on most soils in this country. When cows must leave pasture and go into winter environment, because the change is quite radical, it is very difficult to keep cows producing largely. As a rule they decrease in milk flow at this season provided they have been afforded good pasturage. It is rather early in the season to begin feeding roots, or even corn silage largely, and at this time pumpkins are exceptionally useful. So easily are they raised that every dairyman should provide for their use at the season of the year which may be termed between grass and hay. Very often a poor stand of corn is secured in the spring, and in this event it is advisable to replant the missing hills with pumpkin seeds. Before the advent of the corn harvester this method was more prevalent than at the present time. The objection to it now is that the pumpkins cause trouble in harvesting the corn with a binder. Very often there are fields which are not to be harvested in this manner, and these are the places where pumpkins should be grown or a small acreage should be devoted exclusively to growing this excellent form of succulence.

Experiments show the feeding value of pumpkins to be nearly half as great as is that of corn silage. Practical experience shows them to be even more valuable because of the readiness with which they are eaten by cows milking largely and because of their tendency to maintain or even increase the milk flow at a time when cows are leaving pasture and going into winter conditions.

An idea seems to be more or less prevalent that pumpkin seeds have a tendency to turn cows dry. Experiments indicate that this is an erroneous opinion and that pumpkin seeds, like other seeds, are very rich in protein and fat and, therefore, quite valuable as feeding material provided they are not overfed. Were it not for this fact there would be little, if any, danger of over-feeding pumpkins, but because of the richness of the seeds the feeder should limit the amount of pumpkins fed to 30 to 40 pounds per cow daily.

A method often employed in feeding pumpkins is to break them on the ground and let cows fight for them. A more advisable method is to cut them up into pieces from two to three inches square and feed them in the barn either with the grain ration or separately. Where this method is employed, a portion of the seeds can be removed, which, when carefully washed and dried, can be preserved for planting the next spring.

Potatoes

It often happens that the market price of potatoes is so low as to disappoint the grower and make it to his advantage to feed them rather than go to the expense of marketing them. Even when potatoes are selling at a high price, any grower of them can secure a large total price for his crop by putting them over a grader, selling the biggest of them and keeping the smaller ones to use for stock feeding purposes. Many farmers find it advantageous to cook the potatoes which are not offered for sale and use them for feeding hogs. This is the best outlet for them, but they may be fed to cows in limited amounts. They serve as a source of nutriment and succulence, but are not exceedingly palatable. If overfed, potatoes tend to create a laxative condition in the animal, taint the milk and render the resulting butter white and salve-like. For these reasons, even though they are available in abundance, their use should be limited to 25 or 30 pounds daily per cow. Sometimes potatoes are stored with an expectation of a high market in the spring, which does not materialize. In such instances, where it becomes necessary to feed them to cows or other livestock, care should be taken to remove the sprouts, for it seems they contain a poisonous substance which may cause much trouble if animals are permitted to eat them.

Sweet Potatoes

More valuable than the common Irish potato for feeding purposes is the sweet potato. In the south they are raised very largely for feeding livestock, and it is not uncommon to hear the assertion made by southern dairymen that sweet potatoes afford the very best source of succulence for dairy cows. An experiment performed at the Florida station indicates that practical experience is reinforced by scientific research. It was found that 100 pounds of sweet potatoes produced as good results in milk and butterfat as did 150 pounds of corn silage. On good soil sweet potatoes can be made to yield as much as six or eight tons per acre, and this furnishes as much feeding value as though the same acre had grown from 9 to 11 tons of corn silage.

Sweet potatoes are very palatable to cows and those who have fed them agree that no deleterious effects are produced by them on the milk or butter produced when they are fed.

As a rule, sweet potatoes command a market price so large that growers are tempted to sell them rather than to feed them, but, with a knowledge of their actual feeding value, the dairyman is in position to decide for himself whether he should sell them for human consumption or use them for feeding purposes. Very often in the south it is possible to purchase sweet potatoes at a price lower than

it costs to provide an equal amount of feeding value in the form of corn silage. This is especially true in sections where land is sandy and on which sweet potatoes thrive and corn grows sparingly.

Apple Pomace

Occasionally inquiries are made relative to the value of apple pomace. This is the by-product resulting from the manufacture of cider, which leaves the apple pulp as a waste product unless it can be used as a by-product. These inquiries indicate that in certain sections apple pomace is oftentimes available. In Europe it is used as a by-product with good results instead of considering it as mere waste. It is estimated that from 125 to 150 gallons of cider may be secured from one ton of fruit, leaving the remainder available for feeding and fertilizing purposes.

The chemical analysis of pomace shows it to contain from 60 to 80 per cent of moisture, about 1 per cent of fat, 1 per cent of protein, 1 per cent of mineral matter and about 12 per cent of carbohydrates. According to this, it would appear that pomace is practically equal to wet brewers' grain, silage or root crops for furnishing nutriment.

The chief difficulty found in using pomace is that it very rapidly decomposes after developing alcoholic fermentation and produces acetic acid.

In its fresh state it is eaten readily by all classes of livestock after they have become accustomed to its taste. When used as a feed it should be mixed with concentrates rather than attempting to feed it alone and, when used at the rate of approximately one-third of the total ration, it is found to be most useful.

Because of the rapid deterioration of apple pomace it is necessary to feed it while it is still fresh and sweet or to provide for preserving it. In England the plan has been adopted of making it into silage and also the method is followed of sprinkling salt between layers of pomace that are one foot thick. Under these conditions the pomace settles and keeps well. Where amounts are sufficiently large to make it worth while, drying plants are provided and the pomace dried. The resulting product is one of much feeding value, palatable to all classes of livestock and useful for feeding purposes.

Cocoanut Meal

Occasionally inquiries are made relative to the value of cocoanut meal. This by-product is not plentiful in many sections of the United States but is being fed to some extent on the Pacific coast and is used quite largely in parts of Europe. It results from the manufacture of cocoanut oil and represents a feeding value higher than bran but lower than linseed meal.

Recently, since other feedstuffs have become so high in Europe on account of the war, the agricultural colleges have been experimenting to determine more definitely the value of this cocoanut oil by-product. The conclusions thus derived and set forth by the Journal of the Board of Agriculture indicate that, when judiciously fed, this food may be used to advantage, although it is not very palatable and needs to be fed with a mixture of more pleasing foods. Where the amount is restricted to 50 per cent of the concentrated ration, or less, good results are secured. As cocoanut meal creates a laxative condition in the animal it should be fed with foods that have the opposite tendency.

Only when cocoanut meal can be secured at a price slightly higher than good wheat bran should it be considered seriously as a food for dairy animals.

Palm Nut Kernel Meal

For many years palm nut kernel cake and meal have been manufactured, used largely and exported by Germany. Since the outbreak of the European war many experiments in England and Scotland have been performed with the result that many factories have sprung up for the purpose of manufacturing this feed which has been found very useful and economical for feeding all classes of livestock.

Experiments show that palm nut kernel cake and meal compare very favorably with cottonseed cake and meal but that they are not relished by animals, especially dairy cows, as much as is cottonseed meal. However, after animals have become accustomed to eating them they offer no objections. As is equally true of experiments, the results secured at various stations differed. At some stations the cottonseed meal was shown to be superior while at other stations the palm nut kernel cake was reported to produce more milk and butterfat. In some instances a decision was reached which indicates palm nut kernel cake has a tendency to increase the percentage of fat, and in all instances it was shown that the general health of animals was preserved nicely and that animals fed on palm nut kernel cake had looser skins, glossier in appearance than the skins of animals fed on cottonseed cake. Where it is available, and can be purchased at a price not exceeding cottonseed meal, it may advisedly be used as a part of rations for furnishing protein and fat.

CHAPTER XXXI.

PACKING HOUSE BY-PRODUCTS

There was a time when blood and meat scraps were waste products at the great packing centers. To get rid of them occasioned no little expense. Later the value of these waste products became recognized for furnishing fertilizing elements. Enormous driers were installed at great expense and a tremendous industry developed. In more recent years a market more profitable to the packer has been developed because of the large content of protein and the comparatively large amounts of fat contained in these products that were formerly waste. There were those who realized that foodstuffs of exceptional value would result if they could be prepared in such a manner as to be useful for feeding livestock.

All over the United States and Canada experiments were performed to determine the feeding value of dried blood, meat scraps, bone meal and tankage. In almost every instance it was demonstrated that foodstuffs of rare value for hog feeding purposes had been discovered. As a result improved machinery was installed by the packing houses and today tremendous tonnages of these by-product feeds are on the market and available in nearly every community. So great is the feeding value of them that they have attained a prestige even though the price per ton of the various packing house by-products is large indeed as compared with other foodstuffs when the cost per ton alone is considered. But when the large content of protein and fat contained by them is considered and compared with the cost of these nutrients in other foodstuffs it is realized by the thoughtful feeder that as a rule he can secure these nutrients in a more digestible form at a price not exceeding, and often less than, that which he is compelled to pay when he secures the same nutrients from other foodstuffs which cost less per ton.

It has been found that these products are palatable to hogs but not palatable to cattle. Another drawback is that a distinct and objectionable odor is always present in these by-products and that it is especially noticeable in hot weather. It has been found, however, that these feeds can be used in limited amounts for feeding dairy animals, and blood meal and blood flour have proved themselves especially valuable for feeding young calves.

Blood Meal

At the large packing houses provision has been made for the blood of slaughtered animals to run into a receptacle from which it is quickly pumped into a cooking tank, where it is heated to a point at which the water separates from the clots. It is then placed between large cloths and put under hydraulic pressure to remove the moisture. This leaves the blood in cakes about three inches thick which contains about 50 per cent of moisture. These are placed in a mechanical drier and all but 6 or 7 per cent of the remaining moisture is removed. It then passes through large grinders, is reduced to meal and placed in sacks ready for shipment. The operations are all accomplished quickly in order that at no stage of the manufacture will decomposition of the blood particles take place. During the process of grinding the meal is passed over sieves so fine that any portion of the product dropping through is extremely fine. This is sacked and known as blood flour. It is, therefore, apparent that the only difference between blood meal and blood flour is that the latter is more finely ground and, although both products are soluble in water or milk, blood flour is more readily soluble and, therefore, a more advisable feed for dissolving in milk to feed calves.

Blood is one of the most digestible of all foodstuffs. It is also the most concentrated protein feed. Both the meal and the flour contain over 80 per cent of protein, and there is available, in 100 pounds over 70 pounds of this valuable nutrient in a digestible form. There is a small amount of mineral matter, approximately 3½ per cent, but because it is so largely digestible it is especially valuable. There are no digestible carbohydrates in blood, and less than 1 per cent of fat. Its chief value as a feeding stuff rests in its content of protein and the beneficial effect it has upon the digestive apparatus.

None of the packing house by-products is palatable to cattle. If they are used at all they must be mixed with other feeds. Because of their large content of protein, they are very expensive per ton and, if used at all in feeding dairy cattle, they should be used in small amounts.

At present blood meal is not used to any great extent for feeding dairy cows, and it is not likely that it will ever become a popular feed under average conditions. Where cows are producing largely and the desire is to stimulate them to do their very best, feeders will find it advantageous to add from one to two pounds of blood meal to the daily ration. It must be carefully mixed with other feeds and used in very small amounts in the beginning to avoid causing the cow to leave her entire ration. By gradually and slowly increasing the amount of blood meal fed no trouble will be experienced in inducing the cow to eat as much as two pounds daily.

Blood meal and blood flour are particularly valuable for feeding young calves. Many breeders and dairymen now follow the practice of adding a teaspoonful of the meal, or better, the flour, to each feed of milk given. Calves fed in this manner are less liable to suffer from scours, and because the blood is so extremely rich in protein and digestible mineral matter, it stimulates very rapid growth of bone and muscle. For calves suffering from scours, other than that caused by infection, there is no remedy better than blood flour introduced into the ration as suggested above. It should be understood, however, that only fresh, clean flour should be used. When it gets old it develops a disagreeable odor and calves do not eat it with relish, nor do they seem to do well upon it. It is, therefore, advisable to secure the blood meal or flour direct from the large packing houses, all of which offer it for sale.

So great is the value of blood for introducing digestible protein into rations that many of the large commercial feed manufacturers are now using it for increasing the digestible protein content of the feeds they offer for sale. This being true, the fact is illustrated that the practical feeder can well afford to experiment judiciously with blood meal, provided the rations he is feeding lack the protein which is so essential in stimulating large milk production.

Tankage

Scraps of meat and fat, small particles of bone and some blood, which formerly were wasted in killing establishments, are now carefully preserved, cooked, dried and ground in much the same manner as is blood for making blood meal, and these scraps are manufactured into tankage and meat meal. These by-products are not used in feeding dairy animals because they are not palatable. They are, therefore, not directly useful for feeding dairy animals. Their value is of an indirect nature.

As a substitute for skim-milk in feeding swine and poultry, tankage and meat meal are especially valuable. For this reason they should have careful consideration by the dairyman who sells the products of the cow in the form of whole-milk instead of cream.

It is well known that when whole-milk is sold much more fertility is removed from the farm than when the product is sold in the form of cream. Furthermore, every farmer recognizes the value of skim-milk as a food for young and growing animals. However, where tankage and meat meal are employed to substitute for skim-milk in feeding swine and poultry, that fertility which is lost by selling whole-milk is returned with the tankage. Experiments that have been performed in a large percentage of the stations of the United States and Canada indicate that tankage and meat meal are almost,

if not quite, as valuable for feeding swine and poultry as is skim-milk, and more economical where a good market for whole-milk exists.

These by-products seem to have an advantage over other feed-stuffs in that they, like milk, are animal products rather than the products or by-products resulting from grains and grasses. Especially are they valuable because of the large percentage of easily digested mineral matter, protein and fat they contain. When they form a portion of slops or mashes, they furnish identically the same constituents in quite the same manner as skim-milk.

When the dairyman is able to secure a sufficiently larger price for butterfat in the form of milk than in the form of cream, he is justified in selling whole-milk, reserving only a sufficient amount for feeding and raising his calves well, provided he returns to his farm through the medium of packing house or other by-product feeds a volume of food nutrients and fertilizing ingredients equal to that which the skim-milk he sells takes from the farm.

Because of the large amount of digestible nutrients contained in tankage and beef scraps, the price of them per ton is high, but the rule is that digestible mineral matter, protein and fat may be secured in them as cheaply as from any other source. As long as this is true, their use for balancing rations is advisable.

Bone Meal

It has been shown conclusively by experimenting with growing pigs that size and strength of bone can be materially increased by feeding bone-growing material to young animals. Moreover, milk contains a large amount of mineral matter. As a rule, cows secure a sufficient amount of mineral matter from feed provided them to supply their own body requirements and furnish mineral matter for the milk they yield. The feeder of dairy cattle has given very little consideration to supply mineral matter in his ration for this reason. Nevertheless, there are instances where a lack of ash is the limiting factor in milk production.

As a rule, cows will eat bone meal if the opportunity is afforded them. This indicates that it may be advisable to keep a small supply of finely ground bone meal available in a sheltered place, where cows may lick it as they choose. Where this is done the feeder will be surprised to learn what a large quantity of finely ground bone cows will eat of their own accord. Experiments performed for the purpose of demonstrating the advisability of feeding bone meal to cows have not indicated the necessity of mixing bone meal with grain rations. Until they do, if it is advisable to feed bone meal at all, the best plan will be to make it available and permit cows to eat

of it in amounts such as they choose or such as their requirements impel them to do.

Many dairymen and breeders of dairy cattle have concluded that it is wise to feed ground bone to young calves. It may be fed with the grain ration in such proportions that each calf will secure from one-half to three-quarters of an ounce daily, but, as is the case with older animals, a plan more to be recommended is that of keeping finely ground bone meal available in a sheltered spot where the growing calves may eat of it as they choose. When the opportunity to eat bone meal is afforded calves consume large amounts and seem to thrive so well on it that its use is to be highly recommended.

Following the discussion of the miscellaneous foods, the analyses compiled from Henry & Morrison's "Feeds and Feeding" will give the reader a clear conception of the feeding values and enable him to use them when conditions warrant:

			Digestible nutrients		
100 pounds	Dry matter	Ash	Protein	Carbohydrates	Fat
Beet molasses	74.7	5.2	1.1	59.4	...
Cane or black strap molasses	74.2	6.4	1.0	58.2	...
Field pumpkin	8.3	0.9	1.1	4.5	0.5
Potatoes	21.2	1.1	1.1	15.8	0.1
Sweet potatoes	31.2	1.1	0.9	24.2	0.3
Apple pomace	23.3	1.0	1.2	15.6	0.8
Cocoanut meal	90.4	4.9	18.8	42.0	8.1
Palm nut meal	89.6	4.3	12.4	45.8	9.5
Blood meal or flour	90.3	3.3	69.1	....	0.9
Tankage—high protein grade	92.6	10.5	58.7	....	12.6

CHAPTER XXXII.

APPLYING THE KNOWLEDGE OF FEEDS

After the Cow Is Dry

Those who have studied the preceding chapters have a working knowledge of all foodstuffs available in every section of the United States. They are familiar with the physical and chemical properties of each.

They know which foods are palatable to cows, which are bulky and which are concentrated, which furnish succulence and which furnish dry matter, which are highly digestible and which are not, those rich in ash, those rich in protein, and which ones furnish an abundance of carbohydrates and fat.

The one in possession of this information finds it a simple task to ascertain the cheapest source of the various food requirements from home-grown or purchasable foodstuffs. By dividing the price per ton of any feed by the number of pounds of digestible protein contained in the ton of feed, the cost per pound of this necessary nutrient may be quickly determined. The same process will inform the feeder what each of the other nutrients is costing per pound. Adding together the digestible protein, carbohydrates and fat contained in a ton of feed gives one an excellent idea of the feeding value of that particular foodstuff.

By dividing the cost per ton by the total pounds of digestible nutrients contained therein, a figure is secured that is well for every feeder to consider. It is the figure that denotes the cost per pound of the real, useful, milk-stimulating, growth-producing food nutrients. By comparing the various foodstuffs available in this manner the most economical source of feed for compiling rations is readily located. The reader will remember, however, that this compilation will not alone suffice for drawing final conclusions. It is necessary also to consider the physical value of foods, their palatability and the question as to whether they furnish in a well proportioned manner the essential ingredients, moisture, ash, protein, carbohydrates and fat. As a fundamental principle, however, in selecting feeds it is highly advisable to first determine the cost per pound of digestible nutriment and then the feeder is in position to select from the number of feeds available those which when mixed together will fulfill all of the requirements.

In this day of high-priced feedstuffs this simple process of figuring will eliminate some foodstuffs that have heretofore been consid-

ered most advisable for feeding dairy cows, and feeders will substitute for them other foods which in the past have not been used so largely. It is a process which will serve to reduce the cost of feeding a cow several cents per day in many instances. Thus several dollars are saved for each cow in the herd during a year's time and, therefore, many dollars will be saved in a year in feeding the entire herd. A greater gain still will result, for it is true that, when a dairyman begins using pencil and paper in an intelligent manner, he is led to the discovery that there are several ways whereby he can save in his feeding operations and at the same time increase production and better the conditions under which his animals are kept.

Valuable and necessary—even essential—is this information for the one who would feed for large and economical results either in growing young animals or producing milk and butterfat, and it is the first stepping-stone which leads to compiling suitable rations. It is equally necessary for the feeder to have a clear conception of the distinct purposes for which foods are fed. But a moment's thought is required to show one that the combination of food suitable for fattening a steer might or might not be satisfactory for stimulating a cow to give milk. Valuable as is wood for building houses, it is worthless for making bullets, and excellently as steel fulfills the requirements for making railroad tracks, it does not serve well the purpose of making wearing apparel. And so it is that a ration balanced for growing a calf may not be balanced for a mature cow. Furthermore, it is very true that a ration balanced perfectly for one cow may not be balanced for another or for the same cow at another time. I make this statement because I know the majority of feeders seem to have been led to believe that someone, somewhere, has the knowledge and power to formulate a balanced ration from certain feeds that one may have available, so that by using this fixed ration for feeding every cow in the herd equally good results can be expected from each. Right here is where many feeders make a mistake. It is in this respect that the idea of the balanced ration is theoretical and falls short of its mark, as will be realized as the reader studies further and learns wherein the balanced ration can be used to advantage in other ways than by considering it a sort of a fixed rule or formula. Suffice it to say at this point that no one as yet has been able to devise a ration or a plan of feeding any class of livestock that eliminates the feeder using a plentiful supply of knowledge, judgment, common sense and ability, which only practical experience combined with study will give him .

For a balanced ration to prove as satisfactory in practice as in theory indicates the one who compiles it must have a clear concep-

tion of just what purpose the ration is being balanced for. Even then disappointment is liable to result if it is balanced for the purpose of increasing milk production, provided the cows that are to be fed are far advanced in lactation, for it is well known that Dame Nature plays such a part in controlling milk production that man must work in harmony with her if he is to succeed.

It is for this reason that from this point to the conclusion of the discussion relating to how a dairy cow should be fed the subject will be handled just as though one or more cows were to be fed for the largest and most economical production. I know of only one system that can be followed to obtain best results, and never in many years of study, research and experience have I learned of one who has discovered a system that can be successfully substituted. Therefore, far be it from my purpose to lead my readers to believe that I can convey knowledge that will enable them to adopt rations or feeding methods that may be employed on a herd of cows in various periods of lactation one day and increase perceptibly the milk flow of the herd the next day, or even the following week or month. That is so impossible that only by magic could the feat be performed.

Let us think for a moment of the reason why a cow gives milk at all. It will then occur to us that at a not far distant date the cow was but a beast of the prairie and forest. Like wild animals that roam at will, she had but to live and rear her young. She was vastly different from the high-producing, almost artificial animal we know her to be now. When she conceived she was giving no milk, or so little that she soon went dry so she might use all of her energy to nourish her own body and the little body within her womb, which was there growing in the image of herself and to which she would give birth in due time. To maintain her own body foods of a certain kind and in certain amounts were necessary. She needed a balanced ration the same as cows of today do; perhaps she needed more food because hers was a more active life than is that of the cow that has her food carried to her where she is sheltered from the elements and protected against enemies. But, generally speaking, she needed a maintenance ration which experience and experiments teach us is one that will furnish for every 100 pounds live weight .07 pound of protein, .7 pound of carbohydrates and .01 pound of fat in a digestible form. Let us assume that she weighed 1,000 pounds. Then she would need to gather from here and there enough food to furnish her with .7 pound of protein, 7 pounds of carbohydrates and .1 pound of fat. This she had to have to maintain her own body under ordinary conditions. If compelled to fight or flee from her enemies, extra nourishment was necessary to supply energy for the task.

Moreover, because the calf she was carrying had no other source of nourishment except that furnished from the blood of the mother, it was necessary for her to secure additional food for this purpose, because, let it never be forgotten by the feeder who would succeed, that substance never originates from nothing. For life to be sustained a certain amount of nourishment is absolutely necessary. For a unit of energy to be generated by an animal food nutrients are essential, and to develop a calf, whether during the gestation period or after it is born, demands that from some source or other the necessary amount of nourishment be supplied as food.

These are rules established in the beginning by nature. They are arbitrary and never changing. They must be respected by the feeder, and all experience and experiments known to man from the beginning of time down to the present day prove conclusively that he who disregards the absolute and fixed laws of nature must expect to suffer the consequences.

Therefore, the cow of primitive ages that lived and reproduced herself was compelled to rustle and secure a definite amount of food. In the summer time she ate grass. If the grass was equal in nourishment to our bluegrass, we find by referring to chemical analysis that she had to eat approximately 50 pounds daily to meet her requirements—that is, provided she weighed 1,000 pounds. As a matter of fact, she probably did not eat that much. She required less, for she was a smaller animal, and, therefore, needed proportionately less food. If she weighed only 500 pounds she needed only 25 pounds of green grass to take care of her needs. Sometimes she was able to secure more and sometimes less, and, fortunately, in the beginning nature provided for just this circumstance. She endowed the animal with power to store up fat in and on the body during the months when food was plentiful that she might draw upon this surplus fat and tide her life over those periods of the year when she could not find enough food to provide even a maintenance ration. Oftentimes drouth and long, severe winters made her food supply so short that, after gradually using up all the surplus fat she had stored up, and failing to find enough food to furnish a life-sustaining ration, she died of starvation.

A valuable lesson is to be derived from these facts. No dairyman will succeed who does not learn it and keep the essential points of it uppermost in his mind. For thousands of years it has been the cow's privilege to provide for her own maintenance first, and not in 10,000 years can she be robbed of that privilege. Therefore, the first .07 pound of digestible protein, .7 pound of carbohydrates and .01 pound of digestible fat she has always taken, takes now and al-

ways will take for each 100 pounds of live weight to maintain her body. She takes a little more for developing the calf she perchance may carry and only that which she eats in addition to this amount, which is rightfully hers, does she use to convert into fat to lay on body or place in her owner's milk pail.

When in her original state, if all went well and the food supply was sufficient, the cow maintained herself, developed her unborn calf and became fat. These were the provisions of nature. As she approached parturition what udder she had filled and she gave birth to a miniature likeness of herself, which she nursed, then hid away in the bushes and went in search of food. Regularly and often she returned to feed her baby until such time as it was strong enough to follow her on her foraging trips. At frequent intervals the youngster tugged at its mother's teats, for she gave barely enough milk to feed it, and at no time did she furnish an over-supply. The calf grew vigorously, and in a few months—three or four perhaps—it reached the age where it was able to seek its own subsistence without the aid of the mother. It, therefore, became weaned and the cow went dry that she might take care of herself for a repetition of the ordeal. The calf became a beast of the plains or forest, subject to the law of the survival of the fittest. If it was strong, vigorous and worthy it lived to maintain itself and reproduce its likeness, but if weak and unworthy it failed in the mission for which it was born, and it died. In other words, the maternal, or motherly, instincts of the cow impelled her to give milk, the life-sustaining food, for her infant. This instinct, pronounced as it was when the calf was first born, gradually decreased as the youngster grew, and as this instinct decreased the milk flow diminished and no power could increase it again except the power of nature through the renewal of motherhood and the milk-making instincts that motherhood intensifies.

Recognizing that milk had value as a food, man chose the cow from among the multitudes of wild animals, for she gave proof of her superiority over all other mammals. In the beginning, he depended entirely upon nature's food and methods for stimulating a supply of milk for him. He caught a fresh cow and her calf; killed the latter for veal and milked the former as long as her motherly instincts and the feed she could find between milkings impelled her to produce. When she went dry, all that was necessary was to catch another cow and repeat the performance. Dame Nature did it all in those days.

But man has never been satisfied with letting well enough alone. It was never meant that he should be. Nature merely makes it possible for man to do things and lays down the laws, which, if intelli-

gently followed, will make for success, but, if disregarded, bring failure. She co-operates with man in his attempts to improve upon her methods, but she absolutely refuses to permit him to substitute his laws for hers. Therefore, the improved cow of today and the greatness of her production are but the results of men working with nature, perfecting her laws and thereby patiently increasing the milk flow, lengthening the milking period and molding the form of man's best friend, the dairy cow.

The laws that are followed in making the cow great are as stringent today as they were when the cow was first robbed of her freedom. It is equally as necessary to comply with the first law, which makes milk production possible—the law which compels the cow to give milk, to feed her young, by so intensifying the mother instinct that she will sacrifice her own body to feed the infant of her own flesh and blood.

I have dwelt upon this phase of the feeding subject because without a clear knowledge of these truths no man can feed cows successfully. With a clear conception of them he secures a very different viewpoint of how to feed the dairy cow. He knows where to begin and how to proceed. This is the big secret, for little does it profit to know how to proceed if where to begin is not known, or vice versa. Nature used to take from six to eight months to prepare a cow for freshening, but man has learned to do the work in six or eight weeks. So, when the cow is within eight weeks of freshening she should be turned dry. Common cows usually go dry of their own accord, but it is often hard to turn cows dry that are extra good individuals and highly bred along milk-producing lines. To do so requires placing the cow on a mere maintenance ration—one which does not provide any nutrients for milk-making purposes and one which does not stimulate the cow to rob her own body to produce milk for her master. This is the first ration every feeder should know how to formulate.

Already we have learned that for maintenance purposes the cow needs .07 pound digestible protein, .7 pound carbohydrates and .01 pound digestible fat per 100 pounds live weight. She needs just 10 times this much if she weighs 1,000 pounds, so the problem is that of giving her just enough feed to accomplish the specific purpose of maintaining her body, for it is unwise to decrease her ration so greatly that she will lose flesh at this particular time, as will be seen later.

CHAPTER XXXIII.

FEEDING THE DRY COW

It is generally known by thoughtful dairymen that such foods as timothy hay and corn stover are about as lacking in milk-stimulating properties as any foods known. Furthermore, they are usually available for some reason or other on nearly every American farm. Therefore, it is safe to suggest that an attempt be made to provide a maintenance ration of such feed. With no other foods available, a 1,000-pound cow will eat approximately 20 pounds of timothy hay in a day. Now, by referring back to Chapter XVIII, the analyses of timothy hay and other carbonaceous roughages can be found, and any one or more of them may be used for compounding a maintenance ration in the same way as follows with timothy hay. Of this roughage 100 pounds contains in a digestible form 3 pounds of protein, 42.8 pounds of carbohydrates and 1.2 pounds of fat. Dividing these figures by five, because the 20 pounds the cow is to eat is one-fifth of 100 pounds, the result shows that she secures .6 pound of protein, 8.5 pounds of carbohydrates and .24 pound of fat—hardly a maintenance ration from the standpoint of furnishing protein, although it supplies a trifle more carbohydrates and fat than are necessary. It would not be wise to keep the cow on such a ration long, because additional protein is very necessary at this time for growing the unborn calf. However, it will not be found necessary to use this ration long, for if the cow is milked irregularly, only often enough to relieve pressure on her udder and then milked only partially dry, she will cease giving milk in a few days.

Timothy hay is expensive to use, even for turning cows dry, so let us see how corn stover will serve the purpose. Of this roughage, 20 pounds furnishes in digestible form .42 pound of protein, 8.5 pounds of carbohydrates and .14 pound fat—a ration just a little more deficient in protein and fat than timothy hay and one that can be used with equal success in turning cows dry. This should illustrate, in a conclusive manner, the folly one practices in compelling his cows to seek nutriment from carbonaceous roughages alone, expecting them to produce milk therefrom. They are just barely good enough to use for turning cows dry.

On the other hand, supposing the cow were given 20 pounds of clover hay daily. From this she would receive in a digestible form 1.5 pounds of protein, 7.8 pounds of carbohydrates and .36 pound of fat. This would furnish her with just about the right amount of

energy-making material, but more than twice as much protein or milk-stimulating material as would be necessary to maintain her body. This would be a better ration to use, provided success could be attained in turning the cow dry, because there would remain .8 pound of protein, which would be sufficient for stimulating growth of the unborn calf. Therefore, the conclusion may well be drawn that clover hay is much superior to the carbonaceous roughages for feeding dairy cows, even for turning them dry, except in special instances where an exceedingly persistent cow is found, when it will be necessary and advisable to place her in a stall or dry lot and feed her nothing except timothy hay, corn stover, or some other such dry roughage for a few days.

Feeding the Dry Cow

When the purpose of turning the cow dry has been accomplished, an altogether different kind of ration is necessary, for different purposes are now to be achieved. Whenever a ration suitable for performing definite, desired purposes is formulated, that ration is truly a well-balanced one. No other is.

In preparing a cow to freshen, there are three well-defined purposes for which she should be fed:

First, to complete the growth and development of the unborn calf.

Second, to rest and render most helpful the digestive system.

Third, to store up vigor, strength, stamina and fat in and on the body to be used after she freshens.

From the day the cow becomes pregnant, development in utero takes place. Gradually the embryo grows, being furnished nourishment taken from the food eaten by the mother and carried by the blood.

Nourishing the Embryo

During the first few months of gestation the cow is not drawn upon for a great amount of nourishment because the growth of the embryo is small, but, as it develops into the foetal stage, more nutriment is required, until during the last two months of gestation, when the growth is greatest, a considerable amount of food nutrients is necessary for proper development. This fact is too often overlooked by men who milk cows. It is not uncommon to hear dairymen and even breeders of dairy cattle boast of the fact that certain ones of their cows never go dry. So highly developed along milk-producing lines are such cows that they not only sacrifice their own bodies but those of their offspring in order to yield persistently that for which they have been so intensely bred.

Many dairymen have not been far-sighted in this respect and this fact, to no small extent, is accountable for many weak, puny and

still-born calves that make their appearance on dairy farms. It is a well-known fact that a calf seriously stunted in its development at any time from birth to maturity does not grow into the great animal it otherwise would. Now, it is equally true that the calf whose growth and development are checked and stunted prior to birth is not only robbed of its right to be born strong, rugged and vigorous, but I am confident that many of its superior characteristics are rendered latent to the extent that no degree of good care, feed and management, following the date of its birth, suffice to render dominant the characteristics during its life and there is a probability that such characteristics are not transmitted to the animal's offspring. At any rate, he who would breed and develop most desirable animals must give consideration to development **in utero.**

At birth the body of the calf contains very little fat. It is largely water, and what dry matter there is represents bone, muscle, cartilaginous material, tissue, blood and hair. Carbohydrates and fat derived from foodstuffs play no part in developing these. They are made exclusively from protein and mineral matter. This indicates that, especially during the last six or eight weeks of gestation, the cow should be liberally fed of these food constituents, if proper development of the foetus is to result. Furthermore, it indicates the advisability of having the cow dry at this time because milk also draws largely upon the protein and mineral constituents for its manufacture. If they are used to make milk, they are not available for any other purpose.

Resting Digestion

The large-producing cow is the hardest worked animal on the farm. Even the cow that yields only 20 pounds of 4½ per cent milk daily, which is not an extremely large average daily production for a good cow for a year, yields in seven days an amount of fat—and fat equivalent—in excess of that produced by a steer gaining 15 pounds per week, and in addition the cow gives her owner six times as much protein or nitrogenous material and six times as much mineral matter. Moreover, her product is all edible and so largely digestible in comparison with the steer's product that the actual comparison is even greater.

Now, milk is made from nothing except the food which the cow eats, digests and assimilates. To produce largely, to maintain her own body, and to develop the foetus requires that the cow handle large tonnages of concentrated feeds and roughages during the year. Her digestive apparatus is ever at work, day and night, grinding and digesting. It is the most heavily taxed portion of the cow and the first to weaken under continuous work and heavy feeding. The wisdom of providing a ration that will prove restful to the digestive

system for a month or so is therefore apparent. In providing a suitable ration for the resting period, this thought should be kept in mind, for, although the feed given the cow at this time should be favorable to the digestive system, it must also be feed that will render the cow fit for freshening and starting immediately on another year's milking campaign.

Storing Up Surplus

The amount of strength, vigor, stamina and fat the feeder succeeds in storing upon and in the animal's body prior to freshening determines to a great extent the character of the cow's work after freshening. If she is a good dairy cow and has been properly fed during her lactation period, she is in a poor and emaciated condition when the time comes to turn her dry. She has only a few weeks to recuperate and prepare herself. If she is permitted to freshen without being properly prepared, there is no more reason to expect that she will produce satisfactorily during the coming period of lactation than there is to expect that a horse will race satisfactorily without being conditioned for his work.

Cows that freshen in a poor and emaciated condition test lower, milk less and, because they lack stamina, they are much less persistent than cows that are freshened properly. There is a certain condition of flesh and bloom that every cow should possess at parturition time in order that she may deliver with expediency a strong, healthy, rugged calf, clean well and start strongly producing milk, without it being necessary to immediately begin feeding her heavily. This condition depends absolutely upon the manner in which she has been cared for and fed during her resting period. The ration provided her at this time should be one that will provide carbohydrates and fat in abundance for manufacturing a surplus amount of fat to be stored up in the body, and it should also be of such character that it will impart strength, vitality and stamina.

Without fear of successful contradiction, even though I realize that many believe because a cow is not giving milk she needs to be fed only sparingly and permitted to wrestle her feed from dry pasture, stalk fields or around straw stacks, I wish to go on record as saying that at no other time should a cow be so liberally and judiciously fed as during the time she is resting. At no other time should her ration be so carefully balanced, because three purposes are to be achieved, in addition to maintaining the cow's body, while at other periods only one major purpose is necessary for consideration. No greater mistake is made by dairymen than that of overlooking the absolute necessity of resting their cows, feeding the calves prior to birth and conditioning the animal for her work. He who refuses to

do this should retire from the dairy business, for success is not for him. Regardless of how well bred they are and how great is the ability of his cows to produce largely and persistently, they will never do their best, by a long ways, for so thoughtless an owner.

A ration suitable for the purpose, as has already been suggested, must be a complete ration, furnishing all nutrients. In case it is summer time, no combination of feeds will prove better than pasture grasses in abundance, supplemented with a bit of ground corn, ground oats and oil meal. Those who have turned their cows dry in April and permitted them to graze on the pastures during May and June and freshen early in July have seen the cows in most admirable condition for parturition. They have seen those cows produce strong, healthy, vigorous calves; develop large, distended udders and start in producing exceptionally large volumes of milk. This should not imply, however, that if the cow is to freshen during the latter months of summer or the early months of fall that pastures should be depended upon to fit her for freshening. On the other hand, if pastures are short and dry and insects are pesky, as is so often the case, the cow will have a difficult time securing enough food for them to maintain herself without doing anything else. So, if pasturage conditions are such it is very essential that the same feeding principles be practiced as would be followed were the cow to freshen in the winter, except that green foods, or soiling crops, can be substituted for hay and ensilage, provided this is more convenient and the latter is not available.

Fall Freshening

Thoughtful dairymen—other than those required to sell a given daily amount of milk throughout the year—freshen their cows in the fall. Their reasons for doing so are logical. Cows freshening in the fall will give from 10 to 25 per cent more milk and butterfat in a year than those freshening in the spring. Their product sells from 10 to 25 per cent higher. Under usual conditions on the farm, there is more time to feed and care properly for cows in winter than in summer. Therefore, they receive better care. Better calves can be grown under winter conditions, and at time for weaning from milk they go onto grass and continue to thrive. Labor is more equally divided throughout the year, making it possible to keep the summer help over winter. This means the factory is running full time instead of only half time, and all manufacturers know that overhead expenses must be distributed over every week in the year if the business is to be highly profitable. There are other good reasons for breeding cows to calve in the fall, but these are the important ones.

Nature's Methods

Let us assume, however, the cow is going to freshen the first of July. Although this is a better time than an earlier date, it is not an especially good time for dairy cows to freshen. It is a good time, though, to let one cow freshen, just so Dame Nature can demonstrate how the job ought to be done. She is a past master in doing a thing when she sets out to show man how that particular thing ought to be done, but that is as far as she goes. She assumes no responsibility further than this, and if man is not wise enough to learn from her simple, yet complete and expert, demonstrations, she makes it hard for him the rest of the year.

To freshen the first of July, the cow should be turned dry the first of May before being turned to grass. When dry she should be put in the pasture where grass is most luxuriant and pure, fresh water plentiful and easily accessible. A box of salt should be placed so she can lick it whenever she chooses. Nature will do the rest. She will do it so well that her methods are worthy of any dairyman's study.

Let us secure a clear mind's eye picture of just how she does. It will be the best lesson we can possibly learn on how the dairy cow should be fed and how she should be prepared for parturition.

First of all, take notice of the temperature. It is neither too warm nor too cold. The cow is surrounded with all the fresh air she can breathe, and showered down on her and all around her is an abundance of warm sunshine. Over on the brook the sun shines and, even as it removes the cold from the air, it takes away the chill from the water. You see, Dame Nature is very smart. She knows better than to try to demonstrate feeding methods under adverse conditions. There are no foul-smelling, dark, damp, poorly ventilated barns or weather that is either too cold or too hot for the cow. She will not even try to do her best when cows are made uncomfortable with flies and other insects, and she insists on their having plenty of sunshine and warm water to drink, and freedom to exercise at will. With all of these conditions right, she turns her hand toward furnishing a balanced ration, and here is what she uses:

Green, succulent, palatable, nutritious, easily digested food, which is composed of the nutrients, properly proportioned, in the manner which all scientific and practical investigations have conclusively shown to be necessary.

The cow, surrounded by most comfortable conditions, eats all she possibly can of the excellent ration. Her digestive apparatus is rested, and every day, in addition to nourishing the foetus and maintaining her own body as it should be maintained, she stores up a little reserve fat, strength and stamina.

As parturition approaches, she finds herself in perfect condition. A reasonable wealth of soft fat covers her body. Her eye is clear and bright. She is vigorous, strong and healthy. Her hair is soft and silky and her hide is pliable, oily and elastic. Her udder is distended almost to the point of bursting, and her mammary veins stand out along her underline, showing the largeness and perfect condition of the circulatory system. She is in perfect bloom.

In most respects man can improve on the methods of nature, but in this particular instance, if man learns to imitate nature closely by furnishing proper conditions of environment and feed and thereby is successful in developing so excellent a degree of condition and bloom in his cows, he will succeed well.

Now, assuming that the majority of dairymen are so far-sighted that they have planned to freshen their cows later, let us provide for the cow that is to freshen September 1st. This means she should be dry about July 1st. It may be a little hard to get her dry at that time, so it may be necessary to keep her in a dry lot for a few days with just timothy hay or straw to eat. When she is finally dry she may go back to the pasture where the grass is best. If the pasture is good and furnishes shade and an abundance of fresh water, she will do very well as long as the grass is plentiful. Occasionally there is a year when grass grows well all summer, and occasionally there is a dairyman who farms his pastures and so intelligently stocks them that they are always good when the weather permits grazing. But so seldom do these conditions prevail that it is best to take it for granted that along in July and August it is going to become hot and dry; the grass is going to fail; the weather is going to become extremely hot and the insects pesky. Then the cow will suffer. She will get barely enough dry, unpalatable, dusty grass to maintain her own body. To complete the development of the foetus she must draw upon the reserve she stored up when the pasture was good. If she uses her reserve for this purpose, she will not have it to make into milk and butterfat later. The dairyman who permits her to do this makes such a serious mistake in his management that he sacrifices success.

Therefore, when pastures begin getting poor, it is time to begin feeding. Nothing is more valuable for this purpose than summer silage, and there is no more economical feed. If available, give the cow daily all of it she will eat. Supplement with a liberal allowance of good clover or alfalfa hay. If these are not available, fresh sheaf oats fed liberally will be excellent, or, if far-sightedness has provided a patch of soiling crop, green feed from this source will offer an excellent food supply. Which plan is followed depends upon

conditions. Either plan is simple and inexpensive. Either will suffice to freshen the cow properly just as surely as it provides succulent, laxative food in sufficient abundance to keep the cow increasing in flesh, weight, vigor and health each day.

Winter Freshening

If the cow is to freshen after pasture grasses are gone, the problem of conditioning her will be more difficult. However, if stabling conditions are as they should be, windows will admit warm rays of sunshine, a ventilating system will furnish the fresh air, the stable will be warm, a sheltered barn lot will provide for exercise, and the task of furnishing warm, fresh water will not be difficult. The silo, or the root cellar, will furnish the succulence for the ration in a palatable, easily digested form and also a large percentage of the necessary carbohydrates and fat. These succulent foods should not be overfed, however, but if the cow is given about 3 pounds daily for each 100 pounds of live weight, she will not be overfed. In addition to this, if she is given 1.5 pounds of clover hay or a like amount of any other leguminous hay per 100 pounds live weight daily, she will be supplied with almost as much nutriment as she gathered daily from luxuriant pastures. To make up the remainder, she may be supplied with a small concentrated ration composed of light, bulky, laxative foods. A mixture of five parts ground oats, three parts bran and one part linseed meal is excellent for this purpose. Such a ration is bulky, easily digested, and has a cooling, laxative effect upon the digestive apparatus, even though fed in large amounts.

It is conceded that ground oats has greater power than any other foodstuff in imparting stamina to the animal, so that, even though it may be considered too expensive to feed at other periods, one is justified in using it for this particular purpose. In nearly every section these three feeds are available, at least to the extent of securing them in amounts sufficient for preparing cows for freshening, and, owing to the fact that it is difficult to supply satisfactory substitutes for them, it will be advisable to adhere to their use. The amount to feed daily can be determined only by the condition of the cow. Suffice to say that she should be fed according to the best judgment of her feeder. From 4 to 8 pounds daily should be enough, but if it appears that she will not reach the proper state of bloom on this amount, she should be fed more, even as much as 1 pound daily per 100 pounds live weight, if necessary.

If succulent foods, such as silage, root crop or beet pulp, are not available, it will be advisable to moisten the concentrated ration and, where possible, it will be found highly profitable to cut a por-

tion of the hay into quarter-inch lengths and moisten thoroughly 2 or 3 pounds of this to be added to each feed given the cow. In a way this will take the place of naturally succulent food and aid in maintaining the proper degree of laxativeness of the ration.

Attention When Calving

Regardless of the season of the year when the cow freshens, she should be conveniently located so as to be given attention when calving. This will make it convenient to place her on a mash a few days prior to freshening. Nearly all cows must be taught to eat sloppy foods, and this is advisable, for nothing will help in doctoring a cow more than to have her so fond of mashes that she will eat these even when she will eat no other food. The best time to teach her that mashes are palatable is just prior to calving, when they are so useful. An excellent mash can be made by mixing with 1 pound of bran, 1 pound of ground oats and 1 pound of oil meal, a small handful of salt and enough warm water to thoroughly soften it. To teach a cow to eat a mash it will be found necessary oftentimes to begin by offering the food just barely moistened. This mash if fed twice daily will insure the proper degree of looseness of bowels so the cow should calve and clean normally. At best, she will then be in a fevered condition, which the mashes will tend to reduce. In fact, the mash should be her only food in addition to hay and a limited amount of succulent food for three days following parturition.

CHAPTER XXXIV.

MILK FEVER

Cows that milk largely and test richly are always susceptible to milk fever, and the more fleshy, vigorous, and strong the condition in which they freshen, the more liable they are to be attacked with milk fever, which usually makes its appearance at some time during the first 48 hours after calving. Before the discovery of oxygen and air as cures for milk fever, large production was necessarily sacrificed, for in the majority of cases cows died if they had it. It was, therefore, not advisable to prepare them so carefully for freshening, and thereby large production was sacrificed.

It is interesting to note that the making of large records began shortly after the time when the oxygen and air treatments for milk fever were discovered. Where this disease was formerly greatly to be dreaded in that 98 per cent of the cows which were attacked by it died, little is thought of it nowadays, so seldom does a cow die because of it. More than this, the disease should be prevented if possible because cows having suffered from even a mild attack fail to produce as well as though preventive measures succeed.

Preventive Measures

An ounce and a half of epsom salts per hundred pounds live weight, dissolved in a quart of water and administered carefully as a drench 24 hours before calving, is advisable. If for any reason this precaution is not taken it is especially advisable to give the epsom salts drench to a heavy milking, rich-testing cow in plethoric condition provided calf birth has been easy and non-exhausting. The epsom salts have a cooling effect upon the animal's system and assure a laxative condition of the digestive apparatus.

It is, furthermore, but the part of wisdom not to milk the cow for 48 hours following parturition, for it is during this period that milk fever is most to be expected, although occasionally cases have been known prior to calving and later than 48 hours afterward.

If these precautions are taken, only enough milk being removed from each quarter of the udder to feed the calf and to relieve excessive udder pressure, the danger of an attack of milk fever is reduced to the minimum. There is always a likelihood that high-producing, well fitted cows, other than those with first calves (which do not have milk fever), will show symptoms within 48 hours following parturition in spite of all precautions that may be taken. For this reason the cow should be watched carefully that the first symptoms of the disease may

be detected and treatment applied at once, because if intercepted in the first stages the cow quickly recovers and the ill effects are so greatly lessened as to be almost negligible.

Milk Fever Symptoms

Nearly every dairyman and breeder of high-quality dairy cattle knows the symptoms of milk fever. The cow first becomes slightly excited and restless. She switches her tail, treads with her hind feet, moves about uneasily and bellows occasionally. In a short time she appears weak in the hind quarters, staggers as she attempts to walk and soon gives up, sinking to the floor. She finds herself unable to rise and then ceases to pay any attention to her calf or other surroundings. She partially closes her eyes and, as she becomes paralyzed, throws her head around on her side and lies in a quiet comatose condition.

The pulse is weak and her temperature, which as a rule rises with the first symptoms, sinks three or four degrees below normal. If left without treatment the cow in this condition will die in from 24 to 72 hours without regaining consciousness. So certain is death under such conditions that one could ill afford to own the very best cows and properly prepare them for freshening before the discovery of a reliable form of cure for milk fever.

Milk Fever Treatment

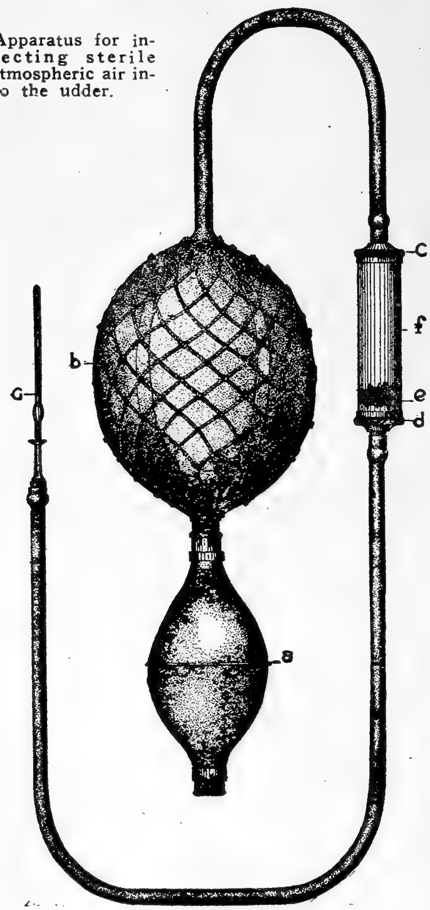
The following description of how to treat and cure milk fever is outlined so fully by John R. Mohler of the United States Department of Agriculture that it is quoted here from Farmers' Bulletin No. 206:

"Of all known methods of treating milk fever, the injection of sterile atmospheric air into the udder is by far the most simple and practicable as well as the most efficacious and harmless one at our disposal, and only occasionally requires that medicinal treatment be given.

"For a considerable length of time the entire value of Schmidt's treatment was considered to be the antitoxic action of potassium iodide, and soon numerous investigators began injecting various other antiseptics, such as carbolic acid, creolin, etc., with equally good results. Sterile water and sterile salt solution were tried with no increase in the mortality, and it was, therefore, considered that the distention of the udder was as important a factor as the antitoxic action of the iodide of potash. Continuing along these lines, Kortman used antiseptic gases (etherized air) with beneficial results. Oxygen was then tried by Knusel with increasing success, and the deaths among the experimental cases virtually ceased. The apparatus for treating with oxygen and etherized air, however, are expensive and cumbersome, and this greatly limits their use by the average practitioner.

"To Anderson, of Skanderborg, belongs the credit of first having made use of plain atmospheric air, although Schmidt had previously recommended the admittance of air with the potassium iodide solution for the purpose of obtaining greater diffusion of the liquid. Anderson first injected air along with sterile water, and then by itself. The results were astonishingly successful. Thus Schmidt reports that out of 914 cases treated in Denmark, 884, or 96.7 per cent, were restored to health. The record of 140 of these animals shows that recovery occurred in the average time of six and two-thirds hours. Of this

Apparatus for injecting sterile atmospheric air into the udder.



number 25 cases required a second injection, while in three of the latter number it was necessary to give a third treatment before they were able to get upon their feet. The treatment is also practically harmless, as the statistics of the above mentioned 914 patients show that only one cow was affected with a severe attack of caked bag after

this treatment, while in four other cows a milder inflammation of the udder was apparent. Equally good results have likewise been obtained in this country.

"The method of injecting filtered air into the udder is easy of manipulation, requires but little time, and is readily accomplished by means of a milk-fever apparatus, such as is illustrated. It consists of a metal cylinder (f) with milled screw-caps (c) and (d) on either end. Cap (c) may be removed in order to place sterile absorbent cotton within the chamber. To this cap the rubber bellows (a) and (b) are connected by 9 inches of rubber tubing. Cap (d) is to be removed together with the attached 18 inches of rubber hose, at the free end of which is the self-retaining milking tube (g), for the purpose of disinfection before treating each case. The pulling on or off of the tubing on the nozzles of the milled caps is thus rendered unnecessary. Within the metal cylinder at (e) is a wire net, which prevents the obstruction of the outlet of the chamber by holding back the sterile cotton, and also permits of the unscrewing of the lower cap and the disinfection of this portion of the apparatus, including the milking tube, without contaminating the packing. Absorbent cotton impregnated with carbolic acid (carbolized cotton) or other suitable disinfectant can be purchased from the drug trade in most localities, and is better, though slightly more expensive, than the plain cotton.

"Previous to making the air injection, the hands of the operator should be thoroughly cleansed and the udder should receive the same careful antiseptic treatment as has been recommended in discussing the injection of potassium iodide. Soap and water should be applied to the teats and udder, after which they should be carefully disinfected with a 5 per cent solution of carbolic acid (three tablespoonfuls of pure carbolic acid to one quart of water). A clean towel should then be placed under the udder to prevent the teats from coming in contact with dirt or filth of any kind. The milking tube, before it is placed in the teat, should have been perfectly sterilized by boiling for 15 minutes, with the lower hose and cap of the cylinder attached, and the apparatus should be wrapped in a clean towel, without touching the milking tube, to prevent contamination before use. If the apparatus has been subjected to this treatment shortly before, and it is desired to disinfect only the milking tube, the latter may be placed in a 5 per cent solution of carbolic acid for five minutes. It is then carefully inserted into the milk duct of the teat without emptying the udder of milk. Air is now pumped from the bulb (a) into the reservoir (b), and thus a continuous flow of air is forced through the filtering chamber and into the udder. Slight massage or kneading of the udder will cause the innermost recesses of the milk tubules to become

distended with the injected air. After one-quarter of the udder is well distended the milking tube is removed, care being taken to prevent the outflow of air by having an assistant tie a broad piece of tape about the teat at the time the milking tube is withdrawn. The same treatment is repeated with the other three teats until the udder is satisfactorily distended. In case the air becomes absorbed and no improvement is noted within five hours, a repetition of this treatment should be made under the same antiseptic precautions as at first. The tape should be removed from the teats two or three hours after the cow gets on her feet, constricting muscles at the tip of the teats being now depended on for retaining the air. In this manner the air may be left in the udder for 24 hours, and when recovery is assured, it should be gradually milked out. It is needless to say that the calf should not be permitted to suck during this period.

"Inflammation of the udder (caked bag) is avoided if the milking tube is thoroughly disinfected before each application, and if the cow's teats and bag and the hands of the operator have been properly cleansed. If the apparatus is kept in its case free from dust and dirt, the absorbent or medicated cotton in the metal cylinder will efficiently filter enough air to distend the udders of six cows. After this number has been treated it is advisable to replace the old cotton with a fresh sterile supply, which should be placed loosely in the cylinder.

"While this method of treating milk fever is a comparatively easy one for a farmer or dairyman to adopt, he cannot expect to have the same successful results as those obtained by a skilled veterinarian, and it is therefore advisable that the services of such a veterinarian should always be obtained in those districts where it is possible. In many cases it will be found that the injection of air into the udder will be sufficient to combat the disease without any other treatment, but it is always advisable to study the symptoms of each individual case and administer in a rational manner the indicated medicines."

Milk fever is not the only trouble to which the newly freshened cow is susceptible. In fact, the most trying periods of her life are those experienced at calving time. Proper feeding prior to parturition usually insures prompt and thorough cleaning. Even so, it is advisable to cleanse carefully and efficiently the vaginal tract with a mild disinfectant solution daily for the first week and then twice a week until the cow is rebred. No procedure will help more to keep contagious abortion and sterility out of a healthy herd or eliminate these difficulties from an infected herd than to make this a rule and follow it with every cow in the herd. Cows that do not clean promptly should be assisted within 48 hours and the same systematic treatment followed, because no amount of care and no system of feeding will

stimulate large and profitable production from a cow that has not fully recovered from the process of parturition. Herein rests the reason for many of the disappointments that result from low production; and no dairyman or breeder can expect to keep a healthy, highly productive herd who overlooks providing the best possible care, feed and management at parturition time.

CHAPTER XXXV.

FEED AND CARE AFTER FRESHENING

When a cow freshens her entire system is in a feverish condition. This is especially noticeable in the inflammation that centers in the udder. Properly fed and cared for, the inflammation is soon removed, but careless feeding and poor management at this period are largely accountable for the many spoiled udders so generally in evidence in dairy herds. As soon as the cow freshens the teats should be tried to ascertain if each is in working order. Occasionally it is found that an obstruction has developed, closing one of the teats. If attention is immediately given with the assistance of a skillful veterinarian and his instruments, little trouble is experienced in saving the quarter of the udder that would otherwise be lost.

Udder Inflammation

Plethoric condition is conducive to additional udder inflammation, indicating that as the dairyman improves his methods of feeding he must also improve his methods of management. However, because the cow has been properly fitted before freshening it is unnecessary to feed her heavily immediately afterward, so that the inflammation is less dangerous and less conducive to permanent udder troubles than though the condition of the cow were so poor that heavy feeding were necessary. It is wise, however, to begin the third day after the calf is born to milk the cow as frequently as three times a day in order to rapidly relieve this inflammation. Carefully rubbing, massaging and fomenting the udder with hot water will hasten the result of bringing it to normal form and condition.

If a seven-day record is the purpose, it will be necessary to handle the cow differently than though she is to be worked for a year. Owing to the fact that seven-day records are ill-advised under ordinary dairy conditions and are used merely for demonstrating what can be done with a cow in a short period of time, it is not necessary to treat of this phase of the feeding subject in a discussion on practical feeding.

Feed Lightly

For the welfare of the cow it is not advisable to crowd her with heavy rations immediately after freshening. In proof of which statement one needs only to have knowledge of the great number of cows with spoiled udders and other evidences of ruin which have resulted from heavy feeding immediately following calving. If the cow is expected to perform largely and persistently throughout an entire period

of lactation, it is well to bear in mind that parturition has weakened her and she should be brought to full feed and to the climax of her production slowly and gradually. The feeding prior to parturition makes this possible and the purpose for which the ration should be balanced now is to so stimulate milk production that the surplus fat stored up by the cow will be gradually converted into milk and butterfat. This requires a narrow ration, or one with a large percentage of protein in proportion to carbohydrates and fat. If winter conditions prevail, the cow should be fed liberally of a leguminous hay and a succulent food. If it is summer and pastures are available, she should be allowed to graze, unless heat and flies are bad, in which event she should be kept stabled in a well-ventilated barn properly screened or darkened during the day time, having green feed or summer silage brought to her, and pastured only in the cool of the evening, at night and early in the morning. She should be fed in addition to this 5 pounds of a concentrated ration, consisting of, or equivalent to, one part linseed meal, two parts ground oats and two parts bran. Oil meal is specified instead of gluten feed, gluten meal, cottonseed meal or other such heavy protein feeds because it is less liable at this time to cause udder troubles, and, associated with oats and bran, forms a ration that is very laxative, easy to digest, bulky and palatable.

Moreover, it is advisable to avoid fattening foods, such as corn and hominy feed, because these will tend to further fatten the cow rather than impel her to go to work in earnest making milk and butterfat at the expense of the reserve body fat she stored up while dry and resting.

It now becomes evident that not only has efficient preparation caused the cow to freshen in the pink of condition with udder developed to proportions almost unbelievable, but her condition is such that it is unnecessary to feed her heavily at the risk of ruining her digestive apparatus and her udder. And, incidentally, it may well be said that more cows are low producers because they are not properly rested, fed and conditioned before freshening, and more cows are ruined by overfeeding during the first 30 days following freshening than by any other cause.

Furthermore, it is plainly seen that not only will more milk and butterfat be secured from the cow in good condition but a great saving in feed will be experienced. In other words, the feed given in conditioning the cow has not been wasted. Far from it. In fact, it always proves to be a source of greater profit than though it were fed the cow at any other period of the year. Instead of being made directly into milk and butterfat it is first made into body fat for protecting the strength of the cow when she needs to be strong and is

later converted into butterfat—provided the cow is rightly fed after freshening.

Before proceeding further, the feeder should bear in mind that a cow will increase in production as largely by raising the ration 1 pound as she will if the ration is raised 4 or 5 pounds at a time. When experience teaches him the truth of this assertion, he can readily see the advisability of raising the ration often by small amounts rather than by large amounts less often, for through this system he is able to secure a larger milk flow when the cow finally reaches the point where she is consuming all the food she is able to handle.

It is a good plan, therefore, to raise the ration the first few days after she is on feed at the rate of only one-half pound each alternate day. After she has gained in strength and is found to be milking largely, it is permissible and oftentimes advisable to raise the ration as much as 1 pound every other day for awhile, but as the cow approaches the point where she is consuming a heavy ration, care demands that again the feeder satisfy himself with raising the ration only one-half pound each alternate day.

Getting a Cow on Full Feed

To definitely illustrate the proper plan of bringing a cow to full feed and to the climax of her production let us assume that a cow weighing 1,000 pounds has freshened and it is the latter part of August. She is just ready to start on dry concentrates the first day of September. As yet her udder is somewhat inflamed and her condition is hardly normal. She is still on pasture nights, but because the flies and heat are severe she is protected and fed silage or soiling crops in the day time. We will assume the cow is just a fairly good grade, the normal test of which is 4 per cent.

By the use of a monthly feed sheet a record is kept of the feed fed and the milk produced each day. This record, compiled by the use of the scales, provides an absolute and very accurate guide for the feeder and also for the milker. Let it not be forgotten that clean milking and careful yet vigorous massaging of the udder must be fully recognized as factors influencing, to a large degree, the attainment of success from proper feeding methods.

When the first month of the lactation period has been completed the record should look something like the illustration on page 227.

To analyze the record is to become impressed with the fact that it has enabled the feeder to keep his hand on the pulse of the cow. It has enabled him to lead the cow instead of causing him to depend upon the cow to lead him. The rule which says, "Feed 1 pound of feed for each 3 or 4 pounds of milk yielded," is a good one to use as a check on feeding operations, for it serves as an indicator and cau-

tions the feeder against gross mistakes from overfeeding or underfeeding. Followed too closely, however, it results in the cow leading the feeder, and is, therefore, a system which eliminates the opportunity of stimulating the cow to reach the climax of her producing ability.

For this same reason all proposed balanced rations, except the ration for maintenance, should be considered as guides that point the general procedure of the feeder rather than rules to be followed to the letter.

The judgment and experience of the careful, intelligent, thoughtful feeder who has a knowledge of the chemical and physical properties of the feeds available, and likewise a knowledge of the individual cow, are the really essential requirements.

But bear in mind that both judgment and experience may be good or bad, and accordingly lead to either success or failure. Good judgment and good experience are the results of determined ambition to get large, profitable results, and this in turn leads to a study of the feeds available, of the cow to be fed and of the results attained daily in the attempt to lead the cow to do her best.

This necessitates weighing the feed that composes the ration. It also necessitates keeping a daily record, so that, if at any time the cow loses in condition or fails to respond in milk flow, the ration may be checked up or analyzed quickly to find the trouble, for even as rules and proposed rations will not alone suffice, neither will experience and judgment unaided serve infallibly.

A combination of rules, proposed rations, experience and judgment—and this means a combination of science and practice—makes a successful feeder.

In the case of the cow, Spot, the feeder assumed that a ration consisting of 2 pounds of ground oats, 2 pounds of bran and 1 pound of linseed meal would serve well to start her on. A ration was formed that was at once palatable, laxative, bulky, easily digested, and not inclined to aggravate udder troubles.

To decide how closely it serves the purpose of encouraging the cow to begin promptly transferring the fat from her body to the pail, the ration is analyzed as follows, presuming that from pasture and soiling the cow is securing the equivalent of 25 pounds of corn silage and 10 pounds of clover hay:

	Protein	Carbohydrates	Fat
Ground oats, 2 pounds	.188	1.008	.081
Bran, 2 pounds	.250	.832	.060
Linseed meal, 1 pound	.302	.326	.067
Roughage	1.090	8.430	.390
Total pounds digestible nutrients	1.920	10.346	.598
Maintenance requirements	.700	7.000	.100
Nutrients left for making milk	.122	3.346	.498

According to Haecker's feeding standard, .054 pound of digestible protein is required for making 1 pound of 4 per cent milk: 1.220 divided by .054 equals 22 pounds—just enough for Spot according to the milk she is giving. According to Haecker, .24 pound of digestible carbohydrates are also necessary for making 1 pound of milk: 3.346 divided by .24 equals 13. Of the digestible fat, .021 pound is also required: .483 divided by .021 equals .23.

There is enough digestible fat but not enough carbohydrates to make as much milk as the cow is yielding; but this is well, for the aim is to compel the cow to draw upon the surplus stored up in her body.

Gradually the ration is raised, always being planned to make sure of a sufficient content of protein (the milk-stimulating nutrient) and an undersupply of carbohydrates. The result is that the cow gradually increases in milk flow.

By the 9th of the month the udder and the cow's condition approach normal so nearly that it is safe to add a heavier feed, such as cottonseed meal, to the ration, and a beginning is made with one-half pound to be increased to 1½ pounds by the last of the month.

By the middle of the month it is noted the cow has lost some flesh and is milking well. She must not be permitted to get poor, so one-half pound of corn meal, rich in carbohydrates, is added to the ration, this to be increased slowly as the month goes by.

But, in this particular case, and in nearly all practical cases, there comes a time when the cow ceases to respond and her milk yield begins to decrease. In this instance the first indication presents itself on the milk sheet September 15th.

What is wrong? Perhaps she has reached her milk-giving limit. Perhaps weather conditions are unfavorable. More likely her ration is out of adjustment. We will check up the ration and see if it is the seat of the trouble. Her ration is shown in the table on this page.

When the total nutrients left for making milk are divided by the .054 pound of protein, .24 pound of carbohydrates and .021 pound of fat, respectively, the requirements for 1 pound of milk, according to

	Protein	Carbo-hydrates	Fat
Ground oats, 3 pounds	.282	1.241	.123
Ground corn, 1 pound	.077	.678	.046
Bran, 2 pounds	.250	.832	.060
Oil meal, 2 pounds	.604	.652	.134
Cottonseed meal, 1 pound	.370	.218	.086
Roughage	1.090	8.430	.390
Total	2.675	12.021	.839
Maintenance requirements	.700	7.000	.100
Nutrients left for making milk	1.975	5.051	.739

Haecker, the results show the ration contains enough protein for 36.5 pounds of milk, enough carbohydrates for 22.4 pounds and enough fat for 35 pounds. This indicates that the cow is drawing upon her reserve, but to continue doing so and to increase further in milk production her ration should be changed promptly and, as she is advanced far

MONTHLY FEED SHEET

Name of Cow Spot *Herd No.* 19
Born, March 16, 1901 *Freshened* August 28, 1917

Record for Month of Sept. *Year* 1917 *Mixture* See Below

DAY OF MONTH	GR OATS	GR CORN	BRAN	GLUTEN	OIL MEAL	COTTON SEED MEAL	MIXED	HOMINY	SILAGE	HAY	Total Grain		LBS MILK
1	2.0#		2.0#		1.0#						5.0#		20.
2											5.0		22.5
3	2.5		2.0		1.0						5.5		24.0
4											5.5		25.4
5	3.0		2.0		1.0						6.0		26.5
6											6.0		27.3
7	3.0		2.0		1.5						6.5		29.6
8											6.5		31.0
9	3.0		2.0		1.5	.5#					7.0		31.8
10											7.0		32.6
11	3.0		2.0		2.0	1.0					8.0		34.0
12											8.0		36.1
13	3.0	.5	2.0		2.0	1.0					8.5		37.0
14											8.5		36.5
15	3.0	1.0	2.0		2.0	1.0					9.0		35.0
16	3.0	1.0	2.0	1.0	2.0	1.0					10.0		34.1
17											10.0		35.0
18	3.0	1.0	2.5	1.0	2.0	1.0					10.5		36.5
19											10.5		37.2
20	3.0	1.0	3.0	1.0	2.0	1.0					11.0		38.0
21											11.0		38.7
22	3.0	1.0	3.0	1.5	2.0	1.0					11.5		39.3
23											11.5		40.5
24	3.0	1.0	3.0	2.0	2.0	1.0					12.0		41.6
25											12.0		42.6
26	3.0	1.5	3.0	2.0	2.0	1.0					12.5		44.0
27											12.5		45.8
28	3.0	2.0	3.0	2.0	2.0	1.0					13.0		46.0
29											13.0		45.0
30	3.0	2.0	3.0	2.0	2.0	1.5					13.5		45.1
31													
Total	87.#	21.#	72.#	23.#	52.#	21.5#					276.5		1058.7
Cost	$1.74	.37	1.08	.41	1.17	.43							$5.20

Total Lbs Milk 1058.7 *Average Test* 4.0% *Total Lbs B F* 42.4 *Income* $16.96+skimmilk
Cost of Feed $5.20+cost of roughage *Net Profit* $11.76–cost of roughage *Net Loss*

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enough in lactation to be sufficiently strong to stand it, her ration is increased on the 16th by adding 1 pound of gluten meal. Adding the nutrients found in this addition to those found in the ration of the 15th and again dividing by the Haecker factors, the results show the pres-

ence of enough protein for 42 pounds of milk, enough carbohydrates for 24.2 pounds and enough fat for 35 pounds. Provided the cow has yet a surplus of stored-up energy and fat and ability to produce more largely, such a ration should stimulate her favorably. Gradually afterward, as the corn and gluten meal are increased, the cow increases in milk flow until on the 28th of the month she milks 46 pounds. On the 29th she decreases again to 45 pounds, and on the 30th an additional one-half pound of cottonseed meal is added to her ration.

This may tend to bring her up again in milk, but she has now been on feed a month. Had she been a great dairy cow she would have increased in milk yield more rapidly, necessitating more rapid increase in ration during the last half of the month.

She is working well, however, and because at no time during the month has the ration contained as much carbohydrates as her yield indicates it should have, the milk has been produced economically. Feed given during the resting period is being returned to the owner in the form of milk and the cow's condition shows she is rapidly returning to dairy form. All indications point to the fact that the cow has reached the limit of her ability to produce milk even though she has not reached the limit of her capacity to eat food.

Further effort should be made the next month to increase her yield and it will be wise to analyze the ration again, for the feeder must now look to guarding the condition of the cow that she will not milk herself down in flesh to the point where she lacks strength sufficient to do her best work the remainder of the year.

On the last day of the month her ration analyzes as follows:

	Protein	Carbo- hydrates	Fat
Ground oats, 3 pounds	.282	1.241	.123
Ground corn, 2 pounds	.150	1.356	.070
Bran, 3 pounds	.375	1.248	.092
Gluten meal, 2 pounds	.604	.878	.088
Linseed meal, 2 pounds	.604	.652	.134
Cottonseed meal, 1.5 pounds	.555	.327	.129
Roughage	1.090	8.430	.390
Total digestible nutrients	3.660	14.132	1.046
Maintenance requirements	.700	7.000	.100
Nutrients left for making milk	2.960	7.132	.946

When the nutrients left for milk-making, after the cow uses those needed for maintaining her 1,000-pound body, are divided by the factors required for making a pound of milk, respectively, .054 pound of protein, .24 pound of carbohydrates, and .021 pound of fat, it becomes more evident the cow has reached the limit of her ability, or that she now needs a larger proportion of carbohydrates in her ration; for, although she is receiving enough digestible protein to make 54.8 pounds of milk, she is receiving enough carbohydrates for only 30 pounds and enough fat for 45 pounds.

It is likely she is now eating more roughage than at the beginning of the month, but she may not be receiving enough. Therefore, it is plain that there are problems for the second month of her lactation period.

The Second Month

Advisable as it is to feed a narrow ration—one containing a large amount of protein in proportion to carbohydrates and fat—the first month following freshening, it is not wise to continue this policy too long. The purpose during the first month is to stimulate large production with a small ration and at the expense of body fat. The

MONTHLY FEED SHEET

Name of Cow Spot *Herd No.* 19
[redacted] Born March 16, 1901 *Freshened* August 28, 1917

Record for Month of October *Year* 1917 *Mixture* See Below

DAY OF MONTH	GR. OATS	GR. CORN	BRAN	GLUTEN	OIL MEAL	COTTON SEED MEAL	MIXED	HOMINY	Corn SILAGE	Clover HAY	Total Grain		LBS. MILK
1	3.0#	2.5#	2.5#	2.0#	2.0#	1.5#			40#	10#	13.5		45.0
2									40	10	13.5		45.1
3	3.0	3.0	2.0	2.0	2.0	1.5			40	10	13.5		44.9
4									40	10	13.5		45.0
5	2.5	3.5	2.0	2.0	2.0	1.5			40	10	13.5		45.1
6									40	10	13.5		44.0
7	2.0	4.0	2.0	2.0	2.0	1.5			40	10	13.5		44.1
8	2.0	4.5	2.0	2.0	1.5	1.5			40	10	13.5		44.6
9	2.0	5.0	2.0	2.0	1.0	1.5			40	10	13.5		45.0
10									40	10	13.5		45.5
11	2.0	5.5	2.0	1.5	1.0	1.5			40	10	13.5		46.0
12									40	10	13.5		46.1
13	2.0	6.0	2.0	1.5	1.0	1.0			40	10	13.5		46.2
14									40	10	13.5		46.0
15	2.0	6.5	2.0	1.0	1.0	1.0			40	10	13.5		46.3
16													46.0
17													46.2
18													45.8
19													44.0
20													44.6
21													45.0
22													44.9
23													44.3
24													44.5
25													44.1
26													44.3
27													43.9
28													44.0
29													43.8
30													43.0
31	2.0	6.5	2.0	1.0	1.0	1.5			40	10	14.0		42.0
Total	67#	170#	63#	42.0#	38.5#	37.5#			1240#	310#	419#		1387.9
Cost	$1.34	$3.06	$.95	$.76	$.86	$.75			$3.10	$2.32	$7.72		

Total Lbs. Milk 1387.9 *Average Test* 4 % *Total Lbs. B. F.* 55.52 *Income* $22.20 + Skimmilk
Cost of Feed $13.14 *Net Profit* $9.06 + Skimmilk *Net Loss* ....

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liberal use of protein in a palatable form accomplishes this. At the end of the first month of lactation the purpose of the feeder changes. The cow has reached the climax of her production if all has gone well.

and she is much poorer than when she freshened. The purpose from this point on through the lactation period is to retain as large a milk flow as possible and keep the cow in good form, health and vigor.

To continue feeding a very narrow ration would cause the cow, if she is a good, well bred, hard-working dairy cow, to become too poor to work persistently, and in most sections the ration would be more expensive than necessary. Therefore, the October rations for the cow, Spot, will appear something like the monthly feed sheet on the preceding page.

It will be noted that an attempt has been made to reduce the percentage of protein and to increase the carbohydrates. However, the fact that an excess of protein has appeared in the ration up to this point does not indicate that the amount called for in addition to that called for by the balanced ration theory has been wasted. This would have been true had the excess been measured by carbohydrates and fat, but not so with protein, because, if more protein is fed than the cow has use for in maintaining her body and manufacturing the protein portions of her milk, she uses it for the same purpose as she would carbohydrates. She has power to do this, but one should not permit this fact to lead to the belief that she also has power to use carbohydrates and fat in substitution for protein. She does not, neither does any other animal. Therefore, be it never forgotten that, regardless of how abundantly a cow may be fed other nutrients, if an undersupply of protein is given this becomes the limiting factor. The cow will draw upon her body for awhile but soon her milk flow will become reduced to an amount which contains approximately that amount of digestible protein afforded by the ration minus that required for maintaining the animal body.

If, however, protein, will serve the purposes of carbohydrates and fat, the reader may question why one needs to use care to feed a definite amount of these two nutrients so long as the ration is abundant and contains a liberal amount of protein.

There are numerous reasons.

Protein concentrates are not as palatable, as a rule, as those that are carbonaceous. An excess of protein may over-stimulate the cow; cause her to over-produce until she weakens, when she declines in production rapidly. Overfeeding protein has ill effects on the reproductive organs. These objections alone suffice to show that over a long period of time cows produce less largely than though the proper amounts of each nutrient were fed. Moreover, in most sections protein feeds are the most expensive so that, though feed may not be wasted, there is a very evident waste of money occasioned by excessive cost of production.

In changing the ration of Spot, therefore, an attempt is made to

gradually add carbohydrates, cheapen the ration at the same time, and still maintain the productive principles of it.

Bran, though comparatively cheap per ton, is usually an expensive food because of the large amount of indigestible material it contains, there being a total of only 60.9 pounds of digestible nutrients in 100 pounds.

Ground corn, also cheap per ton, contains 83.8 pounds of digestible nutrients per hundred weight. Therefore, gradually the bran is reduced to 2 pounds daily while the ground corn is increased to 3.5 pounds. The same objections may be lodged against ground oats, 100 pounds of which contain only 70 pounds of digestible nutrients, even though they are of high quality. For 1 pound of ground oats a pound of ground corn is added, which increases the digestible nutrients, especially the carbohydrates, in the ration, and decreases the cost of it. It is not wise to wholly eliminate oats and bran from the mixture unless they are extremely high in price, for both are palatable, bulky, and furnish mineral matter in desirable forms. Oftentimes, however, other foods, such as Schumacher, sell cheaper and can be substituted without detracting from the producing value of the ration.

It will be noted that we assume the cow is eating more silage also. This she will naturally do as she overcomes the effects of parturition, and in most parts of the country feeders begin depending more largely upon winter roughages and less upon pastures by October.

By referring back to the early chapters of these articles one can analyze the ration and determine how closely it provides for the cow and the milk she is yielding by dividing the content of protein, carbohydrates and fat contained in 100 pounds of each feed used by 100 and multiplying by the number of pounds used in the ration. Thus we find 100 pounds of ground oats contain 9.4 pounds of protein, 51.4 pounds of carbohydrates, 4.1 pounds of fat. Therefore, 1 pound of ground oats contains .094 pound of protein, .514 pound of carbohydrates, .041 pound of fat, and 2 pounds of ground oats contain .188 pound of protein, 1.028 pounds of carbohydrates, .082 pound of fat.

By this simple process the digestible nutrients of all food comprising the ration can be determined and the amount of each nutrient afforded arrived at in the following manner:

		Pounds digestible nutrients in ration		
	Pounds	Protein	Carbohydrates	Fat
Corn silage	40	.44	6.00	.28
Clover hay	10	.76	3.93	.18
Ground oats	2	.188	1.03	.082
Ground corn	4	.276	2.76	.140
Wheat bran	2	.250	.83	.060
Gluten meal	2	.604	.88	.088
Linseed meal	2	.604	.65	.134
Cottonseed meal	1½	.550	.33	.129
Total	63.5	3.672	16.41	1.093

The discussion previously showed how the nutrients in the ration were used by Spot—an individual cow weighing 1,000 pounds, with ability to yield 45 or 46 pounds of 4 per cent milk—and leads the thoughtful reader to desire how to figure for himself and determine how nearly rations fit other cows of different weights and various degrees of ability. To do this the feeder must realize, first of all, that nature protects the cow against thoughtless, heartless owners. It is provided that to live the cow keeps for maintaining her own body a certain fixed amount of nutriment before she begins working for her master. This is well, for the machine must be kept in working order if it is to work efficiently.

It is quite definitely known that for this purpose .07 pound of protein, .7 pound of carbohydrates, .01 pound of fat in digestible form are required for each 100 pounds the cow weighs. Therefore, the 800-pound cow requires .56 pound of protein, 5.60 pounds of carbohydrates, .08 pound of fat, or a total of 6.24 pounds of digestible nutrients, while the 1,600-pound cow must have 1.12 pounds of protein, 11.2 pounds of carbohydrates, .16 pound of fat, or a total of 12.48 pounds of digestible nutrients to be used solely for keeping the body in repair, healthful and prepared to work. This fact should show the feeder who skimps the feed of his cows the folly of his ways, for surely it proves that he is practicing economy so false that he robs his own purse.

Spot's weight being 1,000 pounds, .7 pound protein, 7 pounds of carbohydrates, .1 pound of fat must be subtracted from the respective nutrients she received on October 7th, which leaves 2.97 pounds of protein, 9.41 pounds of carbohydrates and .993 pound of fat to be used for milk-making purposes.

To illustrate how necessary this extra nutriment is for milk-making purposes the following table compiled by T. L. Haecker, which shows what milks containing various degrees of fat are made of, is valuable:

Per cent fat	Per cent protein	Per cent sugar or carbohydrates
3.0	2.68	4.60
3.5	2.81	4.75
4.0	3.08	4.85
4.5	3.27	4.97
5.0	3.45	4.98
5.5	3.65	4.92
6.0	3.82	4.91
6.5	4.12	4.90

Progressing with this information in mind and having access to many years of feed and milk records of the Minnesota University dairy herd, Professor Haecker has determined the amount of the various nutrients that are absolutely necessary for the production of

1 pound of milk of various tests. The following table is compiled from his findings:

Nutrients Required for One Pound of Milk

One lb. of	Pounds digestible nutrients required		
	Protein	Carbohydrates	Fat
3 per cent milk	.047	.20	.017
3.3 per cent milk	.048	.21	.018
3.5 per cent milk	.049	.22	.019
3.7 per cent milk	.051	.23	.020
4.0 per cent milk	.054	.24	.021
4.3 per cent milk	.056	.25	.022
4.5 per cent milk	.057	.26	.023
4.7 per cent milk	.058	.27	.023
5.0 per cent milk	.060	.28	.024
5.3 per cent milk	.062	.29	.025
5.5 per cent milk	.064	.30	.026
5.7 per cent milk	.065	.31	.027
6.0 per ecnt milk	.067	.32	.028
6.3 per cent milk	.070	.33	.029
6.5 per cent milk	.072	.34	.029

Knowing the amounts of the three nutrients available for milk-making, knowing the test of a given cow, and knowing the amount of each nutrient necessary for making one pound of milk, the task of checking up the accuracy of a ration is an easy one.

The table shows that to produce a pound of 4 per cent milk requires .054 pound of protein, .24 pound of carbohydrates and .021 pound of fat. It is merely a problem of division, as follows: 2.97 pounds of protein divided by .054 equals 55: 9.41 pounds carbohydrates divided by .24 equals 40; .993 pound fat divided by .021 equals 47.

This makes it apparent that there is yet too much protein—enough for 55 pounds of milk—only enough carbohydrates for 40 pounds and enough fat for 47 pounds. The cow being on corn silage, which, like linseed meal, is laxative, the latter, a high protein feed, should have corn substituted for half of it, and because a further addition of carbohydrates should replace protein the gluten meal and cottonseed meal are reduced to 1 pound each.

It may be expected, as indicated on the monthly feed sheet, as the ration thus approaches accuracy in supplying the demands of the cow, she increases in milk flow, and, although in September, when she gave 46 pounds of milk, it was believed she had reached her climax, she has been further encouraged with the result that she has reached 46.3 pounds when under careless feeding methods she would have declined in milk flow.

By again checking up the ration in the manner outlined, it will be found that a ration sufficiently perfect for all practical purposes of maintaining the cow and producing 46 pounds of milk is now in use. The cow is producing well. It will be advisable to continue

with this ration till she begins tiring of it, watching her milk production to detect the first signs of this.

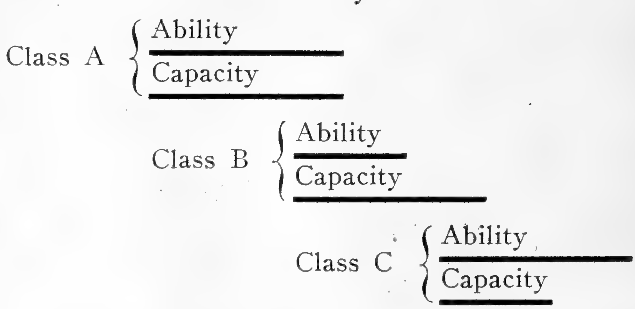
It is to be expected that as the cow advances in lactation she will decrease in milk flow, but the careful feeder will guard against too rapid a decrease, for he knows that it is very difficult, if not impossible, to bring a cow back to her former flow after she has fallen to any great extent. As may be expected, Spot begins giving less milk the last of the month. We will try adding to her ration one-half pound of cottonseed meal and note the manner in which she starts working in November.

The Third Month

An evident decrease in milk flow, even though slight, leads the feeder to change the ration. The natural tendency is to give additional food, but this does not always enlarge production. Every cow has two limits, the ability to give a certain amount of milk of definite richness, and the capacity for eating and digesting a certain amount of food. To feed successfully, to command a large and economical production, to guard the future usefulness of the cow, the feeder must recognize this fact and have knowledge of the limits of ability and capacity of each cow he feeds. In no other way can he know that he is furnishing the proper ration either in amount or quality.

In this regard there are three distinct classes of cows: (a) the class whose ability to yield milk and capacity to eat and digest food are equal, or nearly so; (b) the class with capacity to handle large amounts of food but lacking in ability to yield milk; and (c) the class with ability to produce much milk but so lacking in capacity that their extra ability is useless because they are unable to handle enough food to tax it.

These three classes of cows may be illustrated as follows:



The cow highly developed in both capacity and ability seldom gives trouble to the careful feeder. She eats well at all times and responds with certainty to good care and abundant, well balanced rations. Unfortunately, these cows are not in the majority and are represented by the great record cows of the various breeds.

As a rule, the cow's capacity to eat food is greater than her ability to give milk. This is invariably true of scrub, grade and lowly bred cows. It has been assumed to be the case with Spot. With such cows the feed and milk sheet are a safe guide because, by manipulating the ration in the manner demonstrated, the limit of the cow's ability is determined long before she is eating as much food as her capacity will permit. In other words, she could eat more food without sickening or impairing her future usefulness. In the past, the objection to feeding more heavily than the cow's ability would warrant has been less than it is today, when feeds of all kinds and dairy products are so high in price. However, it is well known that all feed given, over and above that which is necessary to stimulate the cow's greatest ability, is wasted and worse than wasted because it taxes the digestive apparatus and in return yields nothing. It is equally true that, if overfed, the cow will yield less than her maximum, because some of the energy she might use in making milk she must use in digesting unnecessary food. Thus, even as there is a loss occasioned by underfeeding, a double loss results from overfeeding and from using rations improperly balanced. It causes a waste of food and a sacrifice of milk.

There is quite a large class of cows whose ability to produce milk surpasses their capacity to eat and digest food. These are cows resulting from breeding butter records to butter records without regard to constitution and capacity, two very important characteristics of type. So greatly is the milking function developed in these cows that they continue to increase in milk yield with every increase made in the ration. In this manner they encourage the feeder, who following the dictates of the scales and test alone, failing to observe closely enough the physical condition of the cow, continues to raise the ration. Then the inevitable happens. Too much feed is given. The cow sickens, refuses to eat, declines rapidly in milk flow, becomes gaunt, and much skill is necessary to revive a normal condition. Never again is she as good a cow as she was before she "went off feed." Ever afterward she will be more difficult to feed. She will be more susceptible to overfeeding because her digestive system, inherently under-developed, has been further weakened as a result of overfeeding. Such cows are often encountered by the feeder who tries for large records, and it is not uncommon to find them in any herd where the attempt is made to secure large and profitable production.

The careful feeder is always on the lookout for such cows. When one is found in the herd, additional judgment on his part is called into service. In addition to studying the milk and feed sheet he watches the cow—both ends and the middle of her. When the eye begins to

get dull, when the hide begins to get hard, the hair harsh and standing on end, and when the solid excrement shows the digestive apparatus is not working efficiently, the ration should be decreased.

MONTHLY FEED SHEET

Name of Cow Spot *Herd No.* 19
[redacted]-Born March 16, 1901 *Freshened* August 28, 1917

Record for Month of November *Year* 1917 *Mixture* See Below

DAY OF MONTH	GR. OATS	GR. CORN	BRAN	GLUTEN	OIL MEAL	COTTON SEED MEAL	MIXED	HOMINY	Corn SILAGE	Clover HAY	Total grain		LBS. MILK
1	2#	6.5#	2.0#	1.0#	1.0#	1.5#			40#	10#	14.0#		42.5
2									40.	10			42.0
3	2	7.0	2.0	1.0	1.0	1.5			40.	10	14.5		41.0
4									40.	10			41.5
5	2	7.5	2.0	1.0	1.0	1.5			40.	10	15.0		41.2
6									40.	10			40.0
7	2	7.0	2.0	1.0	1.0	1.5			40.	10	14.5		39.1
8									40.	10			39.5
9	2	6.5	2.0	1.0	1.0	1.5			40.	10	14.0		39.0
10									40.	10			39.2
11	2	6.0	2.0	1.0	1.0	1.5			40.	10	13.5		40.0
12									40.	10			39.6
13	2	6.0	2.0	1.0	1.0	1.5			40.	10	13.0		39.8
14													39.5
15													39.2
16													39.0
17													38.1
18													38.0
19													38.5
20													39.0
21													38.7
22													38.4
23													38.6
24													38.2
25													38.0
26													38.1
27													38.0
28													38.3
29													38.2
30													38.0
31													
Total	60#	189#	60.#	30.#	30#	36.#			1200#	300#	405#		1178.2#
Cost	$1.20	$2.37	$.90	$.54	$.67	$.6			$3.00	$2.25	$6.28	-	

Total Lbs. Milk 1178.2 *Average Test* 4.0 % *Total Lbs. B. F.* 47.13# *Income* $18.85 + Skimmilk
Cost of Feed $11.53 *Net Profit* $7.32 + Skimmilk *Net Loss*

Herd Record System Form 8. Price 35c Per Dozen Prepaid. FRED L. KIMBALL CO., Waterloo, Iowa

These indications show the cow is eating more feed than she can handle safely. She has closely approached the limit of her capacity, although, by continuously increasing in yield with every increase of feed, she shows that the limit of her ability has not been reached. The limit of her capacity prohibits her from ever reaching the limit of her ability.

Her ration must be gradually decreased while time will permit. If this is postponed until the cow begins leaving her feed, a serious

condition will result. Even if the life of the cow is saved, her future usefulness will have been impaired. But if the ration is decreased, the cow given a physic—a pound of epsom salts or, better, a quart of linseed oil—when the first signs of overfeeding appear, she will quickly return to normal and her feeder will know he has discovered the amount of feed the cow is capable of handling. In the future, he will keep his rations below this maximum amount. Thus it is that no fixed rules can be established for feeding all cows. Judgment on the part of the feeder must always be recognized as the all-important factor and when this is applied freely in conjunction with a knowledge of feeds, cows, balanced rations, feed and milk records, each individual cow in the herd can be induced to give her maximum yield with a minimum of feed.

As is the case with most cows, it is assumed that Spot has capacity for more than 13.5 pounds of grain daily. When at the end of her second month of lactation she had decreased from her maximum daily yield of 46.3 pounds to 43 pounds an attempt was made to check a further decrease by gradually increasing the ration. On the 31st of October, one-half pound of cottonseed meal was added; on the 3d of November, one-half pound of corn, and a like increase was made on November 5th, but to no avail, as the milk record shows. Therefore, this extra feed would be wasted if left in the ration, so it is again taken away and the daily amount of feed further reduced to 13 pounds by the 13th of the month. This represents approximately 1 pound of feed for each 3 pounds of milk yielded. The ration is well balanced, furnishing all necessary nutrients for maintaining the cow's body and keeping her in good working condition, and she is producing as favorably as is to be expected. It is evident that the proper ration for the present has been established. So long as the cow keeps in good form and continues to yield favorably there is no occasion for changing her ration. It is no more advisable to make unnecessary changes in rations than to fail to make necessary changes.

The Succeeding Months

As the months go by a natural decrease in milk flow will follow, but the cow should increase in richness of test, so there is not a radical decrease in butterfat production. Cows differ greatly in this respect, but where the feed and milk sheets, together with the individuality of the cow, are studied carefully and used as guides, it is oftentimes possible to so encourage persistency that the cow will be yielding more than half as much milk and nearly as much butterfat at the end of her lactation period as she did when at the climax of her production.

A readjustment of the ration will usually be found necessary once

a month—sometimes oftener—during the remainder of the lactation period along the same lines exemplified by the record sheets of October and November. For the most part the revision will be downward but occasionally the feeder will wish to increase slightly the ration that he may be sure enough feed is being provided to stimulate the cow's best work at all times. As a guide for showing him that the ration is well balanced and the cow working efficiently—not wasting food—the rule that 1 pound of food should produce 4 pounds of 3 per cent milk or 3 pounds of 5 per cent milk will be found very helpful.

It must not be assumed, however, that a certain ration will serve equally well for all cows. Although it has been taken for granted that foods combined in definite proportions impelled Spot to do her best work, another cow under identical conditions might refuse to do her best, and herein rests the advisability of weighing and recording the feed eaten and the milk yielded. The feeder studying each cow, realizing that large records are not made by the dozen but by individual cows, is enabled to vary the rations according to the demands and welfare of each cow in the herd, thereby securing the greatest and cheapest production possible.

The particular feeds used in the tables are not the only feeds that can be successfully used. They were selected because in nearly all sections they are available, and all feeders are familiar with them. It often becomes advisable for the sake of economy to use other foods, and the dairyman should always remember that the selection of foodstuffs has much to do with the profits accruing from his cows. For instance, hominy feed can be used instead of corn, Schumacher feed can be substituted for oats, ground oats and cut or ground alfalfa can be substituted for bran, and vice versa, cowpea or soy bean meal can be substituted for gluten meal, cottonseed meal or oil meal. In fact, the dairyman who has knowledge of the various cattle foods, with regard to relative composition, digestibility, palatability, and physical properties, is in a position to choose the foods that are to compose his rations in such a manner that he will not only be able to stimulate the largest but also the cheapest production.

Furthermore, it is often possible and advisable to use a ready mixed dairy ration, the guaranteed feeding value of which is known to be such that it supplies all requirements other than those furnished by home-grown foods that need to be reinforced. Such use of reliable ready mixed rations make it possible for the feeder to purchase one feed in carload lots rather than several others in job lots. This enables him to enjoy carload freight rates and wholesale prices, plus a small commission for the middleman. If discriminating selections are made, using knowledge which determines the merits or demerits

of foodstuffs, it is possible to secure mixed feeds that are always uniform in feeding value and more efficiency mixed than feeds can be mixed on the farm. As is the case in selecting all foods, farm-grown, by-products or mixed feeds, the essential points of producing value and economy must be considered by the feeder. Let it never be forgotten that even selling home-grown feeds—such as timothy hay—and investing the proceeds in foods more useful for feeding purposes is advisable, and only by having a clear knowledge of feeds and their characteristics (including composition, digestibility, palatability, physical properties and cost) can this be wisely accomplished.

With this explanation the reader will find it possible to arrange rations suitable in quantity and quality to encourage large, persistent and profitable production for the remaining months of the cow's lactation period. By thus succeeding with one cow, he will ever afterward be able to feed successfully as many cows as he may have charge of, for by recognizing that each cow is an individual unto herself, capable of dictating her needs through the mediums of the milk and feed sheet and her physical condition from day to day, the feeder will realize that no one is in such good position to determine how each cow in the herd should be fed as he is.

As the fall-freshened cow advances in lactation, fall gives way to winter, and naturally, the cow tires of rations that are always the same. She becomes dainty and refuses to eat with avidity. It is then advisable to make slight changes which will provide variety without lessening the feeding value of the ration. Roots may be substituted in part for silage, alfalfa hay for clover, hominy feed for ground corn, etc.

Large, yielding cows that require heavy rations not only need variety; they need an occasional rest of digestive system. Because at parturition time they were taught to eat mashes with relish, it is possible and advisable once a month or oftener to substitute, for one feed, a mash consisting of 1 pound each of bran, oil meal and ground oats, well salted and moistened. No decrease in milk flow will follow, and at the next feeding hour a renewed appetite will be in evidence. This plan will often forestall heavily fed cows sickening of food and failing to work well to the end of the lactation period.

Under usual conditions it is desirable for cows to freshen every year. This necessitates breeding them when they are advanced three months in lactation. It is the nature of some cows to decrease perceptibly when conception takes place, while others continue to milk as largely as they otherwise would. Therefore, the ration should be readjusted, if necessary, to comply with this characteristic of the cow in the same manner as in coping with other individual peculiarities.

When spring comes with warm days, it will be advisable to re-

duce the ration slightly and gradually, for less food is required in warm weather than when it is cold, less being needed for generating heat to maintain body temperature.

By observing the feed and milk sheet the proper degree of reduction will be readily discovered, it being presumed that the carbonaceous feeds which are the heat producers are the ones to be decreased.

Even as feeders often make the mistake of leaving their cows on pasture too late in the fall, thereby losing greatly in milk production, greater mistakes are made by sending cows to pasture too early in the spring.

Early spring grasses are largely water. They contain very little feeding nutriment. It is true that when cows are first turned into pasture, even though it may be in the early season, they increase in milk flow. This does not indicate, however, that they are securing a great abundance of food nutrients. It more likely indicates that the grass is serving as a tonic and a stimulant to encourage cows to transfer from their bodies the nutrients that have been stored up during the winter.

An excellent rule to follow is to keep the cows in the barnyard and upon winter feed 10 days to two weeks after the decision has been made to send them to pasture. Wise men often change their minds. After the decision to turn the cows into the pasture field is made, it will be the part of wisdom to change the mind and postpone the transfer for at least 10 days.

After cows get a taste of green grass, they do not eat their silage and other winter feeds with the same avidity they did before leaving the barnyard. Consequently, if they do produce more largely, it is at the expense of their bodies, and the loss in production will come twofold in later months.

Furthermore, if cows are turned into pasture too early, the grass is not given an opportunity to get a good start so it will grow well throughout the season. It is kept close to the ground and, when finally summer droughts arrive, pastures resemble board floors by the absence of feed produced. Grass should be 6 inches high before cows are turned onto it. Then a sufficient start will have been gained so that throughout the season, unless over-pastured, an abundance of feed will be furnished.

When grass attains a height of 6 inches, sufficient nutriment is stored so that the cow is enabled during her grazing hours to secure a volume of feed large enough that, instead of acting as a stimulant, it furnishes nutrients out of which the cow can make milk in abundance with ease.

Changing cows from winter ration to grass is a radical change. It will, therefore, be advisable to gradually accustom the cows to

pasturage. In doing so, the animal body is protected against abnormal stimulation and will retain throughout the season much of the stamina and energy stored up from expensive winter rations.

Let the cows go to pasture two hours the first day, three hours the second day, four hours the third day, and thus change gradually from winter quarters to spring environment. In the same manner, the winter ration should be decreased slowly and regularly, that the increase in milk flow which follows will be permanent rather than of a temporary character.

It is a saving rather than a waste or extravagance to continue feeding dry feeds, especially hay, until after the cow has become well accustomed to the green grass and refuses to eat with avidity the food she lived on during the winter.

Grain should not be taken entirely away from cows that are producing largely. A certain amount of food nutrients are absolutely necessary for the manufacture of milk and butterfat.

Knowing that pasture grass contains 80 per cent or more of water, it is not reasonable for the feeder to believe it possible for the cow to consume a large enough amount of green stuff to furnish nutrients for an exceptionally large flow of milk. It is true she will continue to yield largely on grass alone for a period of time, or so long as the green, succulent, palatable, easily digested grass stimulates her to do so at the expense of her body, but when finally she has robbed her framework of the residual effects of winter feeding she will decline rapidly in her milk flow, never to return again until another freshening period.

Cows that have been properly fed during the winter go to pasture in excellent condition. The securing of this condition has been an expensive process extended over a period of six months or longer. Therefore, it is a short-sighted policy, indeed, for the feeder to ignore the importance of conserving it as he does when he permits green, watery pasture grasses, by their stimulating character, to transfer this substantial condition to the milk pail in a temporarily enlarged flow.

To cows giving 20 pounds of 5 per cent milk or 30 pounds of 3 per cent milk, it will pay well to continue feeding some grain to furnish nutrients, and a little hay to furnish dry matter. Dairymen are rapidly coming to the point where they realize that it pays to keep cows eating a little silage throughout the entire summer, so that when the customary drought arrives this succulent food may be increased to guard against the natural decrease of milk flow which is experienced on every dairy farm during a part of the summer time when the weather is hot, flies pesky and pastures short.

How true it is that the majority of dairymen are good feeders in the winter time but very poor feeders in the summer time. During the winter, they themselves must shoulder the responsibility of feeding their cows; but in the summer time they trust wholly to nature, and nature refuses to assume the entire responsibility, for a part of it belongs to the dairymen who profit from the milk the cows produce.

Grain in Summer

Under practical conditions as they exist on dairy farms a very light grain ration will be found necessary during the flush season of grass for the fall-freshened cow that is due to freshen again the coming fall. As she advances in gestation her milk flow naturally decreases when summer comes, and if she is due to freshen the latter part of August she should be turned dry in July. Preparation for another year's work, as previously outlined, should then be started. Even as success has resulted from the systematic plan of feeding the individual cow for one year, so will success come year after year, provided the herd is made up of good cows. Furthermore, the feeder who has followed the plan described—even though he has practiced it on only one good cow—has learned much of practical value regarding feeding. Success has made him confident that he knows how to feed in the future to secure a large, profitable production from any cow possessed of ability.

Winter and Spring Freshened Cows

Cows that freshen in late winter or early spring must be fed all summer in quite the same manner as has been outlined for winter feeding, except that grass will take the place of silage and hay until the period of drought comes. Then it will be necessary to again resort to the use of hay and silage or soiling crops. The question of kind and quantity of grain necessary during the several summer months can and should be determined in identically the same manner as the most suitable ration was determined for winter feeding. Experiments show that cows will produce just about enough more milk when fed grain on pasture to pay for the grain. These experiments also show that cows keep in better condition, and because of added strength and vigor derived from the grains they will produce more persistently. Also, the good effects of the grain will carry over into the next lactation period, causing a greater production than though no grain had been given the cows during the previous pasture season. Therefore, grain fed to cows on pasture is paid for directly by increased production and earns a handsome profit as a result of the residual effects which are noted later.

This is especially true of the winter or spring-freshened cow that yields heavily when on pasture. There is a very good reason for this.

Green grass contains so little dry matter that the cow is unable to eat a large enough quantity for maintenance and for supplying nutrients for a large volume of milk. If she is fed no grain or other dry matter, she is compelled to draw upon her body reserve—and this the stimulating character of grass impels her to do. Consequently, although she milks heavily when on pasture, she unfits herself for large work at the end of her year and it is difficult to rebuild the body reserve to a point where she will yield well the next lactation period.

This is but additional evidence pointing to the fact that, where conditions will permit, cows should be freshened in the fall. A saving of dry feed is made during the summer months and, at the season when all farmers are busy in the fields, cows can be idle, resting and requiring less care and attention. Winter and spring-freshened cows must be given a rest between lactation periods, the same as cows that freshen in the fall. This resting period comes at a season of the year when dairy products are high and when there is plenty of time available for milking large-producing cows. In this way such cows not only demand more labor and expense during busy months, but they make a sacrifice of high-priced products during other months.

CHAPTER XXXVI.

FEEDING TEST COWS

Thus far the discussion of feeding has centered around the cow kept solely for profitable milk production. Breeders of purebred dairy cattle, although realizing that fundamentally cows are bred for profitable milk and butterfat production, desire to give individual cows large records that will demonstrate the greatness of capacity and ability. Records enhance the value of the cow herself, the family to which she belongs, and especially her offspring. In order to demonstrate these capabilities the breeder is willing to sacrifice, to some extent, economy for largeness of yield. The method of feeding, however, does not differ from that which has been recommended in previous chapters, except that purebred cows of especial excellence are more capacious and have greater abilities than the assumed cow, Spot.

Such cows are so highly bred that they will yield more largely and, therefore, necessitate being fed more heavily. By the use of the feed and milk sheet, however, and by studying the daily conditions of the individual cow, the feeder conducts his operations in identically the same manner. He is justified in disrespecting to some degree the rule that a pound of feed should produce four pounds of 3 per cent milk or three pounds of 5 per cent milk, and usually the strife for largeness of records leads him to continue adding feed to the ration just as long as there is an increase in butterfat yield—no matter how small—so long as the present or future usefulness of the cow is not impaired.

The feeder is also inclined to postpone breeding the cow so that she may work the entire 365 days and yet have time to rest six or eight weeks before her next lactation period begins. Therefore, whether the ambition of the feeder is to secure reasonably large production and the greatest possible profit from milk and butterfat yielded or to secure the very largest production of milk and butterfat, regardless of profit, the process of feeding is the same, the only difference being in the amount of feeds given, and perhaps in that a larger variety of feeds is offered to stimulate the appetitie of the animal.

It will be found in later chapters that more difference is found in the nursing, care and management of test cows as compared with average dairy cows than is to be found in the methods of feeding.

CHAPTER XXXVII.

CARE AND MANAGEMENT OF TEST COWS

Satisfactory results from feeding dairy cows hinge so largely upon care and management that no discussion of feeding suffices which fails to consider this fact. Even as expert nursing is as essential a factor in curing the sick as is medicine, so is expert caretaking as essential a factor in working the cow as is feed. If a sick man be harshly treated, kicked and cuffed about, compelled to lie on a cold, damp surface, subjected to uncomfortable conditions occasioned by cold drafts, flies and lice, excessive heat or cold, or if he be confined in a dark, close room with no ventilation and compelled to breathe foul air, no amount of medicine, no matter how efficiently it is prepared or how great its virtues, will do him much good. A cow kept under like conditions will fail to do much good, no matter how well her feed may be prepared or how efficiently her rations may be balanced.

An abundance of good feed, good care and good management should go hand in hand. One without the others counts for nothing more than failure. Even as it is necessary to properly feed the cow every day in the year, so is it necessary to give her proper care each day.

Especially during the period of preparation for freshening, good management should be provided. Fresh air, sunshine, exercise and warmth to the extent of comfort—and no more—are essential.

A cow kept tied in an uncomfortable stall and surrounded by darkness and foul air will deliver a weak, puny calf, predisposed to all diseases that make it so difficult to raise calves. Even though it may live, the calf has been robbed of its better inherent qualities and never develops into the good animal it would if it had been given proper embryonic care as well as food.

On the other hand, a danger equally as hazardous argues against letting the cow run with the general herd during this period. Open cows and heifers come in heat at regular intervals, and the observant livestock man notes that this excites most the cows heavy in calf. No performance more than that of riding other cows has greater tendency to cause abortions. It may cause cows that are not infected with contagious abortion germs to lose their calves; it is almost sure to cause cows that are so affected to lose theirs. Calling to mind the fact that approximately 90 per cent of all cows harbor contagious abortion germs and that nearly all herds contain such cows, the only sensible plan is that of so managing all springers that

they may be reinforced against these germs that occasion greater loss in the dairy world than all others combined. Therefore, a rule which prohibits open cows running with cows well along in gestation is a part of good management.

If the cow is to freshen in pasture season she secures exercise, fresh air and sunshine as she grazes, and the sun has removed the chill from the water she drinks and from the air she breathes. Not so with the cow that freshens in winter. She should be given a well bedded, dry, comfortable, well lighted and well ventilated stall—a box stall is preferable—and it will be well if she is permitted to exercise daily in a lot sheltered from cold winds and have water to drink which comes direct from the well or spring, or which has been warmed. Such management, supplementing the suggestions for feeding which have preceded, will insure a healthy condition of the cow and her offspring.

Owners of valuable cows make it a part of the system of management to be present when birth is given to calves so that if there is trouble, as there often is, aid can be furnished. If cows are good enough to own and keep, if it is desirable to prevent accidents, if the life of the calf and the cow is worth saving, then this plan is advisable in all herds where good management is purposed.

If the cow cleans promptly—as she likely will as a result of good care and feed—much trouble will have been prevented. If she does not, the vaginal tract should be thoroughly cleansed twice daily by injecting a mild solution of warm water and a non-irritating disinfectant. This treatment will serve, as a rule, to free the cow from the afterbirth within 48 hours, but if not it should be mechanically removed by a veterinarian unless the one in charge has had experience that fits him to do this work with safety. All cows should be flushed out with the warm disinfectant solution daily for a week following freshening and then twice a week until they are rebred. This aids greatly in keeping cows breeding regularly and free from contagious abortion.

Throughout the year that management which provides greatest comfort for the cow at all times, and insures for her surroundings that keep her in the best of health, vigor and condition, must be supplied if best results are to be secured from feeding. It is possible to overfeed but never possible to overcare for cows, unless it be that by continuously working around them their rest is broken. This indicates that milking, feeding and caring for cows should be done regularly, quietly, carefully, promptly and efficiently. Between milking and feeding periods the cow should be left to herself as much as possible that she may eat, drink, rest and make milk.

Frequency of Milking

Under average dairy conditions cows should be milked twice daily, the time intervening between milkings being as nearly equal as possible. If the length of time between the night and the morning milkings is greater than between the morning and the night milkings, it may be expected that a larger flow of milk, testing lower, will be secured in the morning and the total production will be somewhat less. It is, therefore, advisable to make the time between the milking periods as nearly equal as possible, and it goes without saying that cows should be milked regularly, and each cow should be milked by the same milker. Cows object to unnecessary changing.

In herds of good cows it very often occurs that extra large milkers are discovered. Any cow giving 40 pounds of milk daily, or more, should be milked three times. By so doing, udder troubles will be prevented, milk and butterfat production increased, cost of production decreased, the persistency of the cow encouraged and, because the last milk tests more richly than the first, a slightly increased percentage test of the total milk flow will be secured. The question of how often a cow should be milked depends upon the quantity of milk she is capable of yielding. Under no circumstances should her productive ability be handicapped by not being milked often enough, and never should she be milked so often that the profit from her production is erased by extra trouble and expense of milking. Many a good cow has been ruined because her owner failed to milk her three times a day instead of twice, and many good cows would develop into phenomenal cows were they milked three times daily in addition to being fed and cared for properly.

Watering

The cow is a beast of habit. If the plan of watering to which she has become accustomed is that of giving her water only once daily, she will refuse to drink oftener even if the opportunity is afforded. A cow will live fairly well if allowed to drink only once daily, for she has large storage capacity, but she will not do her best unless watered oftener. The cow that has her own way about it develops the habit of drinking often. It is this fact that indicates the value of indoor watering devices for individual cows. Their use is to be recommended to the one who will keep them clean, sanitary and pure, not only because cows do best when they can drink often but because individual drinking bowls prevent the spread of infectious diseases which so often occur when cows all drink from the same receptacle.

All water should either be warmed in winter or given fresh from the well or spring. Cows should never be compelled to drink ice

water. The cow's normal temperature is approximately 100 degrees. If she drinks cold water, she must heat it in her body by the use of high-priced feed. She will do this if compelled to, but it is much cheaper to heat water with coal, cobs and kindling than with corn, oats and bran. Moreover, to milk largely a cow must drink large volumes of water. Cows will drink heartily of warmed water and remain comfortable. They will drink much less of ice water and suffer.

Salting

Salt is an essential to the health of cows and therefore to persistent milk production. A portion of that which is required may be fed in the grain ration to add to the palatability thereof, but care should be taken not to overfeed it, because too free a use of salt reduces production almost as greatly as does too limited an amount. A good rule to follow is to place in the feed one-half ounce of salt daily per cow and then give free access to a supply of salt that the cow may satisfy her own appetite. In this way, an abundance is assured and overfeeding is guarded against.

Preparation of Feed

All grain fed to cows should be finely ground. If it is not, a large waste of feed results. Furthermore, the cow is a hard-worked animal and needs her time for making milk rather than for grinding feed. Care should be taken to use only foods of good quality, for moldy feeds are dangerous to the health of all animals. If one chooses feed wisely, making certain of palatability, food value and economy, it is always more advisable to feed a variety of foods rather than any one or two. As a rule, cooking or moistening foods simply incurs extra labor. The digestibility of them is not increased. It may be lessened, for when feeds are fed dry the saliva is more thoroughly mixed with them and digestion is thus aided. It is customary, however, for those feeding cows for large records to moisten and sometimes to cook or steam foods, the belief being that greater production is thereby attained. The reason, however, is that moist or steamed foods are more palatable and are eaten more readily and more largely. It is more advisable to moisten the foods with hot water than to cook them because excessive heat renders protein undigestible, thus detracting from the feeding value.

Frequency of Feeding

The cow, being the possessor of four stomachs, does not need to be fed as often as do non-ruminating animals. If, however, cows are milked twice daily, it is convenient to feed them twice, and if milked three times daily, it is convenient to feed them three times, and this factor establishes the number of times they should receive foods of a concentrated nature.

It is not wise to so train cows that they must be fed while milking. It is much better to milk and then feed because cows will milk freer when not occupied with eating. More sanitary milk can be produced because, if feeds are distributed before milking, more or less dust will be present in the air. It is always well to feed cut or chaffed hay or straw with the concentrated ration to add bulk unless it is fed with silage or roots, which accomplishes the same purpose. An excellent plan is that of feeding the concentrated rations, either mixed with or placed on top of the succulent food. When the succulent and grain rations have been eaten, the cow should be given that amount of hay which she will clean up readily. Because a certain amount of dry matter is necessary, the overfeeding of succulent foods should be guarded against.

Kindness

It should be so well known as not to need even the suggestion that cows should be cared for with regularity and kindness. That which torments or excites a cow detracts from production. No other animal responds to kind, regular, efficient care so promptly as does the cow with a highly organized nervous system, and no other animal reacts adversely with such certainty to irregularity, mistreatment and excitement. From season to season certain changes in the care, feed and management of cows are necessary, but all such changes should be made carefully, slowly and gradually. Radical changes, even though they tend to improve upon conditions, detract from production if made too hastily.

Cleanliness

Cleanliness is all-essential in the dairy, not only from the standpoint of sanitary milk production but for insuring large, profitable yields of milk and butterfat. Disinfectants, of which sunshine is one of the best, are invaluable. The breeder should always strive to keep a herd free from germs and parasites. Cleanliness of barns and animals and sanitary methods will accomplish this purpose if applied intelligently, persistently and regularly.

CHAPTER XXXVIII.

MILKING THE COW CORRECTLY

There is not much to be gained by feeding a cow unless you are determined to get all the milk and butterfat the feed makes. You cannot get all the milk and butterfat the feed makes unless you milk the cow right. A large percentage of cows are not milked right, so a large loss of milk and a larger loss of butterfat result. It is as important that cows be well milked as it is that they be well fed.

Milking should be systematically done. This is generally known and acknowledged to the extent of regularity but few who milk cows systematize the operation further. Milkers are usually boastful of the number of cows they can milk in an hour. Sometimes they lay claim to the ability of milking a cow dry and that they accomplish the purpose with dry hands. Very seldom does one lay claim to the art of co-operating with the feeder in an attempt to encourage persistency of milk flow or enriching it. However, the milker can do more towards increasing the test of a cow, and almost, if not quite, as much by way of stimulating a large, persistent yield of milk as can the feeder.

Therefore, a treatise on feeding the dairy cow, to be complete, must urge not only the feeder to stimulate the cow to make milk and butterfat, but also it must urge the milker and tell him how to secure the milk and butterfat after it is made.

The best way to dry a cow is to leave in the udder comparatively large quantities of milk. The best way to encourage large and persistent milking is to systematically take from the udder every drop of milk at regular intervals. If leaving in the udder large quantities of milk turns a cow dry, leaving in the udder small quantities of milk detracts from persistency.

Whether the cow is to be milked by hand or with a machine, she should be prepared for milking. The first step in this direction is to cleanse the udder and flanks. This is advisable because milk is a food for human beings and there is no more justification for the man who disregards cleanliness in milking a cow than there is for the woman who disregards cleanliness in frying potatoes; not as much, because the cooking of potatoes kills the germs that may happen to accompany the dirt to the skillet, but milking a cow does not kill the germs that happen to accompany the dirt to the milk pail.

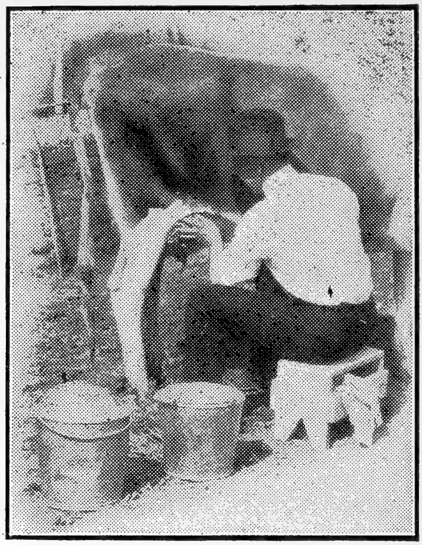
But this phase of the question pertains more to sanitation than to largeness of production and, regardless of sanitation, the cow should

be prepared for milking before the actual process of milking begins.

It is not infrequent to hear milkers abuse, with words and otherwise, cows because they will not give down their milk, when by all rules of common sense the milker and not the cow is deserving of the abuse. A cow is not merely a reservoir containing a given volume of milk that she can give down, or hold up, as she chooses. The process of giving milk is an intricate one governed very largely by the nervous system of the animal which may be controlled through the cow by the milker. A brief review of the manner in which milk is made reveals this fact. A cow giving milk is a continuous worker. Unlike other animals, she works 24 hours a day, eating, digesting, assimilating food and depositing the digested nutrients in the udder and making milk and butterfat therefrom. Her udder, from outward appearances, is composed of four quarters and four teats. These quarters, however, are each peculiarly and wonderfully composed. In this respect cows differ very largely and to the extent which they differ they may be classified as good cows or poor cows, other things being equal.

Just above the base of each teat in the udder little reservoirs called milk cisterns are to be found. These vary in capacity, but they are seldom large enough to hold more than about one-half pint. Above these milk cisterns are the milk-making glands which appear to the naked eye more like a large sponge than anything else with which they can be compared. Only with a microscope can definite knowledge regarding them be secured. Such a study shows the glands to consist of small cavities varying in size connected with little canals, each canal leading upward and terminating in tiny cavities which are called alveoli. Surrounding and associated with each microscopic alveolus is a mass of arteries, veins, lymph vessels and nerves. In the udder are innumerable active centers of this kind, and each is a little factory unto itself. In other words, it is in the alveoli that the elaboration or manufacture of milk takes place. The alveoli are separated from each other by tissues which support and give form to the udder but otherwise have nothing to do with milk-making. An overabundance of this tissue in comparison to the size and numerousness of the alveoli causes an udder to be large but fatty or beefy in texture, and therefore inefficient. The udder made up largely of alveoli with just enough of the connective tissue to give form and support to it represents an ideal structure, and it is such an udder that may increase to large proportions between milkings and, as the process of milking takes place, decrease in size or collapse and when milking is finished hang like a dishrag.

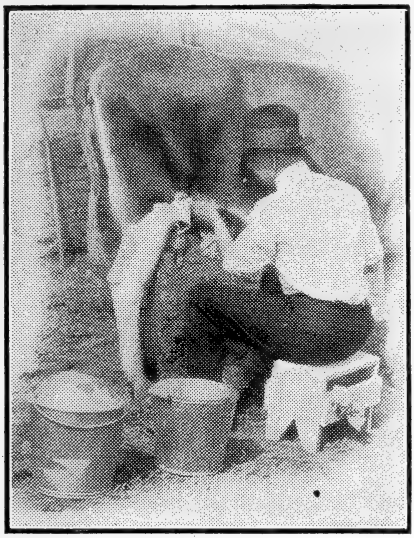
Between milking periods the cow eats and digests food. The blood pumped out from the heart passes along the digestive system,



First carefully wash the udder, teats and flank with a cloth or sponge moistened with water that is warm in cold weather or cool in warm weather.

picks up or absorbs the digested nutrients, and carries them to the alveoli. Here they are deposited for elaboration and the udder is expanded by their presence. Contrary to the belief of many, the udder never contains any great amount of milk. This has been proven conclusively. A cow milking heavily may be killed just before time to milk and the udder dissected and it will be found that only a small quantity of milk is present in the cisterns just above the teats and a small drop of milk will be found here and there among the alveoli and the tissues of the udder.

This brief explanation illustrates the fact that the true manufacture of food nutrients into milk takes place during the few minutes occupied by the actual process of milking. This is the reason why the art of milking is of so much importance. It is the reason why the manner in which the cow gives down her milk is so largely under the control of the milker. It is the reason why the cow should be prepared for milking before the actual labor of milking begins. It is the reason why the milker should have the confidence of the cow that he may encourage her to have full and favorable control over her nervous system, which in reality governs the elaboration or manufacture of milk. It is the reason why the excited cow fails to give down her milk freely and completely. That method of approaching the cow at milking time which quiets her nervous system, frees her from fear and gives her confidence that she is not to be harmed, causes the milk manufacturing centers to work normally and efficiently. Likewise, that which generates fear and a lack of confidence in the cow affects



Washing the udder, teats and flank being followed promptly with a soft, dry towel, causes the cow to begin converting nutrients into milk

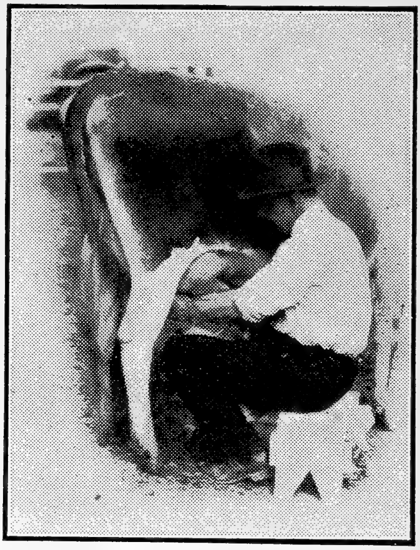
the entire nervous system, including the small nerves affecting the alveoli, with the result that milk is made hesitatingly and inefficiently and a small flow of milk, slowly yielded, is received.

It is, therefore, apparent that to hastily sit down and grab a pair of the cow's teats, or without giving warning attach the milk cups of a machine, acts unfavorably upon a prompt and free release of the volume of milk.

The advisable method is that of approaching the cow in a friendly, quiet manner, and first carefully washing the udder, teats and flank with a cloth or sponge moistened with water that is warm in cold weather or cool in warm weather. From a sanitary standpoint the adding of a small amount of non-odorous, efficient disinfectant is advisable because it kills germ life that may be present to affect the quality of milk adversely, and such frequent applications of a mild disinfecting solution keep the teats free from sores and cracks. The application of moisture proves comfortable and reassuring to the cow, and this, being followed promptly with a soft, dry towel, causes her to begin converting nutrients into milk, which she is prepared to give freely to her master. Furthermore, when this method is followed, the necessity for wetting the hands at intervals—a most abominable practice—is eliminated, for the cow's teats will be in the most pliable and acceptable condition for milking.

But a moment is required for the cleansing and drying process which, if carefully applied, is a large saving of time and temper.

Which teat to milk first is largely a matter of convenience to the



Milking should begin slowly, the rapidity being increased as the freedom with which the milk comes increases.

milker, but milking one hind teat and the opposite front teat and then the other pair tends to keep the quarters of the udder more even and uniform in size and shape than though the usual custom of first milking the front pair of teats and then the hind pair is followed.

The actual process of milking needs little discussion, for if the milker keeps his finger nails closely trimmed, grasps the teats with a full hand, close up to the udder, and applies just enough pressure tending downward without unnecessary pulling or stretching the teats, milk will come freely and rapidly.

Milking should begin slowly, the rapidity being increased as the freedom with which the milk comes increases. Once begun, the milking should be done quickly but without hurrying.

Finally, when the stream becomes small and the milk comes sparingly from one pair of teats, the other pair should be milked with the same system and promptness. By that time, more milk will have entered the first pair of teats and they should be milked out and such a second milking given to the other teats, always using the full hand and never tolerating stripping with the thumb and finger. Cows having teats so short that the stripping method seems absolutely necessary should be disposed of or always milked with machines. Life is too short to sit and strip milk with the thumb and finger especially, because the process spoils a cow causing her to become a slow, tedious milker, requiring so much time for milking that she fails to be profitable.

When all possible milk has been obtained by this quick, easy and

simple method, the udder should be rather vigorously yet carefully manipulated to stimulate the milk-making glands to further and more complete activity; for it is the last milk that is richest and most valuable; and, furthermore, manipulation is the best method of increasing size, activity and efficiency of the glands, which respond in proportion to the completeness of their development.

The cow milked in the manner thus far described, although only partially milked, is better milked than is the general custom. However, it is at this point that the extra minute or two already saved by the expert, systematic milker is put in good use. More milk, extra rich in quality, can yet be secured. The question of whether this milk is secured and how determines to a large degree the richness of the entire volume, the persistency of the cow and the completeness with which her milk-yielding powers are developed.

The athlete knows that exercise, followed by rubbing, massaging and manipulating the muscles, makes them stronger, more active and more efficient. The expert milker finds this to be true also regarding the milk-making glands. To accomplish the purpose one athlete follows one method while others accomplish the same purpose by using methods entirely different in detail but the same in general principle. But each recognizes some one method and follows it systematically. Likewise, various methods may be employed in manipulating the cow's udder, but each milker should adopt an efficient method and follow it systematically. "Practice makes perfect." By following the same plan every time each cow is milked, the operator soon becomes so expert that no more time is required for securing all of the milk than is required to obtain only the first part of it. In fact, because the cow gives her milk more promptly and more freely and because the detrimental practice of stripping is eliminated, systematizing the work really saves time. It does more than this. That which is considered an irksome job becomes an interesting occupation. When ambition enters with the milk pail, drudgery leaves with the litter carrier.

To illustrate with one of scores of instances the writer has experienced: A young man, particularly willing to work and almost over-ambitious to excel his associates by securing comparatively large and rich yields of milk from a string of cows he was milking that he might win promotion and milk a string of cows on official test, was at the point of discouragement because, regardless of how hard he worked, the milk sheet showed his cows decreased more rapidly in milk flow than those milked by others and the Babcock tester gave them a lower test.

One morning, as he was sitting down to milk a heifer, the superintendent handed him a pint bottle and asked that he fill it, taking

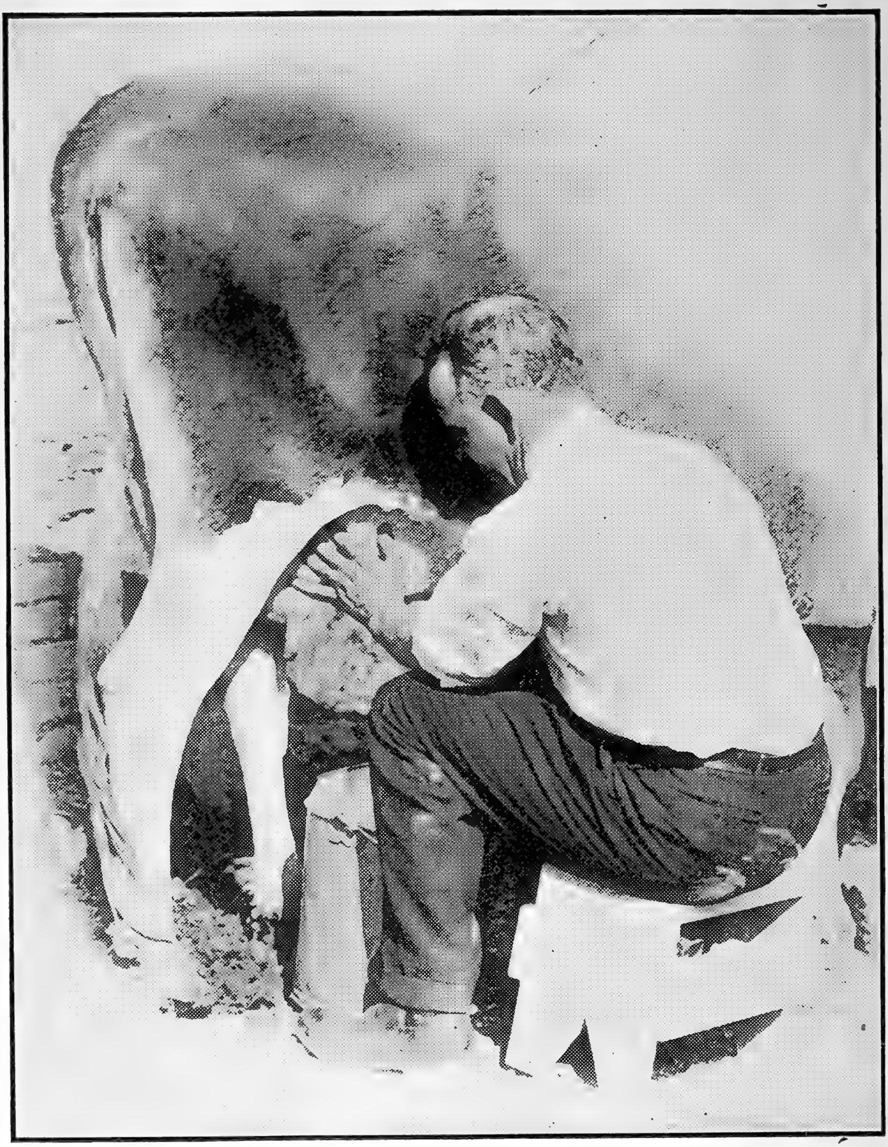


Figure A. The front quarters are firmly pressed together and then like pressure is applied to the hind quarters.

equal portions from each quarter. This done, the bottle was labeled and set aside.

The second pint bottle was presented to him with a like request just as he had presumably finished milking the heifer and was leaving with his pail of milk. He protested that no more milk could be secured, but the superintendent insisted. The attempt was successfully made and later the two samples thus secured were tested with the assist-

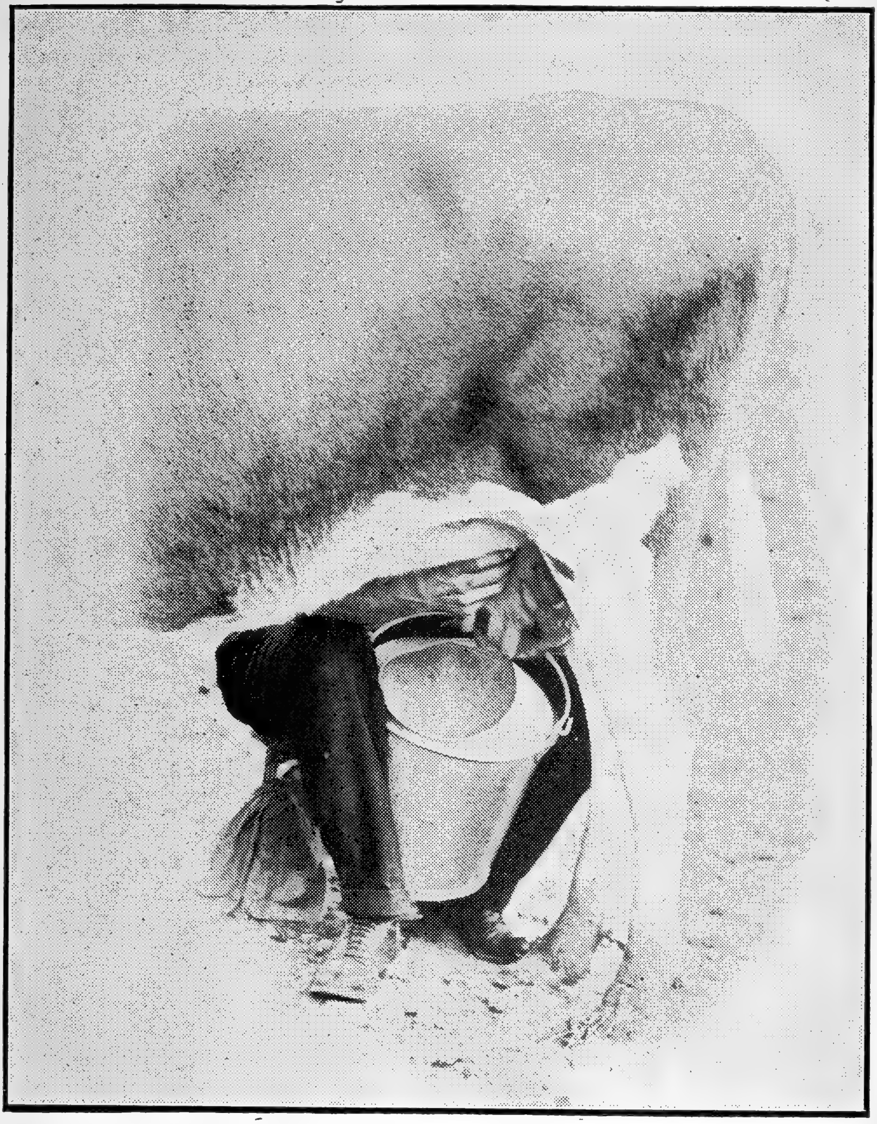


Figure B. The front and rear quarters on one side and then on the other receive pressure from the hands.

ance of the milker, who was amazed to find that the first sample tested only 2.3 per cent while the second one tested 15 per cent.

Even as is a word to the wise sufficient, so this demonstration proved to be the necessary lesson to the willing worker, ambitious to become an expert milker. From that day on he was the best milker in the barn. His cows always tested highest and milked most persistently because he had learned how to legitimately add to each milk-

ing of every cow a pint of milk, creamy in richness, and the manner in which he secured it exercised, stimulated and developed the milk-making glands.

Methods Are Numerous

The method of manipulation is important only to the extent that systematized effort saves time and, being uniform in application, greater response may be expected. It has long been known in European countries that efficient milking depends upon udder manipulation. Different methods are employed in different parts of the country. In Bohemia, where farms and herds are small, it is desirable and necessary to obtain all that is possible from an individual. Cows and goats are strenuously milked.

The method employed is to set the pail aside after the first milking is finished and then gently yet vigorously slap the udder with the palms of the hands several times and then proceed with a second milking. From this process have been derived the terms "cow slappers" and "goat slappers," which terms are frequently used in referring to expert milkers.

Dr. Hegelund of Norway was the first to outline a definite, systematic method of udder manipulation. So great were the results secured by him that his method, original and with deviations, is very largely used all over Europe and by those in this country who have realized that milking may be so scientifically accomplished as to become an art.

Professors Woll and Carlyle of the Wisconsin Experiment Station many years ago carried on extensive experiments to determine the merits of udder manipulation as recommended by Dr. Hegelund. After testing the plan on a few cows in the college herd they practiced on 12 different herds containing a total of 142 cows, found on

Herd No.	Number of cows tested	Average yield per day		After milking		Average gain		Range in gain of fat for individual cows
		Milk pounds	Fat pounds	Milk pounds	Fat pounds	Milk per cent	Fat per cent	
1	11	23.1	1.09	.75	.09	3.2	8.1	2.2-22.3
2	10	49.0	1.66	1.79	.14	3.7	8.3	2.7-23.6
3	12	31.2	1.58	.55	.07	1.8	4.4	1.5-11.3
4	8	25.5	1.10	.76	.08	3.0	7.5	2.2-15.9
5	8	18.6	.83	.61	.07	3.2	7.9	3.8-12.5
6	15	28.4	.80	1.87	.16	10.2	20.1	4.4.37-5
7	8	13.5	.59	1.25	.13	9.3	22.4	9.6-58.5
8	10	26.8	.85	1.08	.08	4.0	9.2	2.8-19.7
9	6	12.0	.54	.59	.06	4.9	11.5	4.3-21.3
10	10	11.7	.61	.81	.12	6.9	19.1	3.9-71.9
11	11	16.0	.62	1.02	.10	6.4	16.2	4.4-72.1
12	8	20.8	.92	1.68	.18	8.1	19.7	5.5-57.2
Univers'y herd	25	22.3	.93	1.01	.09	4.5	9.2	3.0-30.2
Total and av'ge	142	....	...	1.08	.10	5.3	12.6	1.5-72.1

practical dairy farms. The preceding table shows the average yield of milk and fat secured by milking as generally practiced, that produced by after milking, the average gain and the range in gain of butterfat for the individual cows of the herds:

It will be noted that there was a total average daily gain of 1.08 pounds of milk, .10 pounds of butterfat, and that these gains amounted to an increase in production of 5.3 per cent in milk and 12.6 per cent in butterfat. The most striking knowledge is that portrayed by the column which shows the great difference in gain of individual cows in every herd experimented with. The fact that the variation ranges from 1.5 per cent to 72.1 per cent shows plainly that every milker should be equipped with knowledge of udder manipulation that such knowledge may be employed with cows where it is most necessary at least. The results of the experiment show conclusively that it is profitable to methodically manipulate the udders of all cows at every milking, and very apparently it is absolutely essential in order to secure more than 28 per cent of the production certain cows are capable of yielding. So fully is this recognized in Denmark—which country is noted because of the large average production secured from her cows—that one-week short courses are held for the specific purpose of teaching how cows should be milked. Women, boys and girls attend these short courses by the thousands because they are the ones who do most of the milking in Denmark. The result is that, instead of being considered a necessary task and irksome duty, milking there is considered a most honorable mission, and those who milk cows pride themselves in doing so efficiently, scientifically, even artistically.

There can be no doubt that this education in milking cows, which is so generally given in Denmark, accounts largely for the extra production. Although the scholar secures the diploma after attending school only one week, Denmark has, by appreciating the discovery of Dr. Hegelund, profited to the extent of millions of dollars annually and attained the distinction of being by far the greatest dairy country, size considered, in the world.

An excellent method of udder manipulation, which may be very profitably employed by those who milk cows, and especially by those desiring to secure record production, is shown by the accompanying illustrations. When the first milking is finished, the front quarters are firmly pressed together and then like pressure is applied to the hind quarters, according to Figure A. The front and rear quarters on one side are then grasped with the hands and pressure applied as shown in Figure B. The process is duplicated with the quarters on the other side. Then, reaching as high as possible, the milker grasps the two rear quarters and presses as illustrated by Figure C. The same manipulations are then accorded the front quarters. These operations

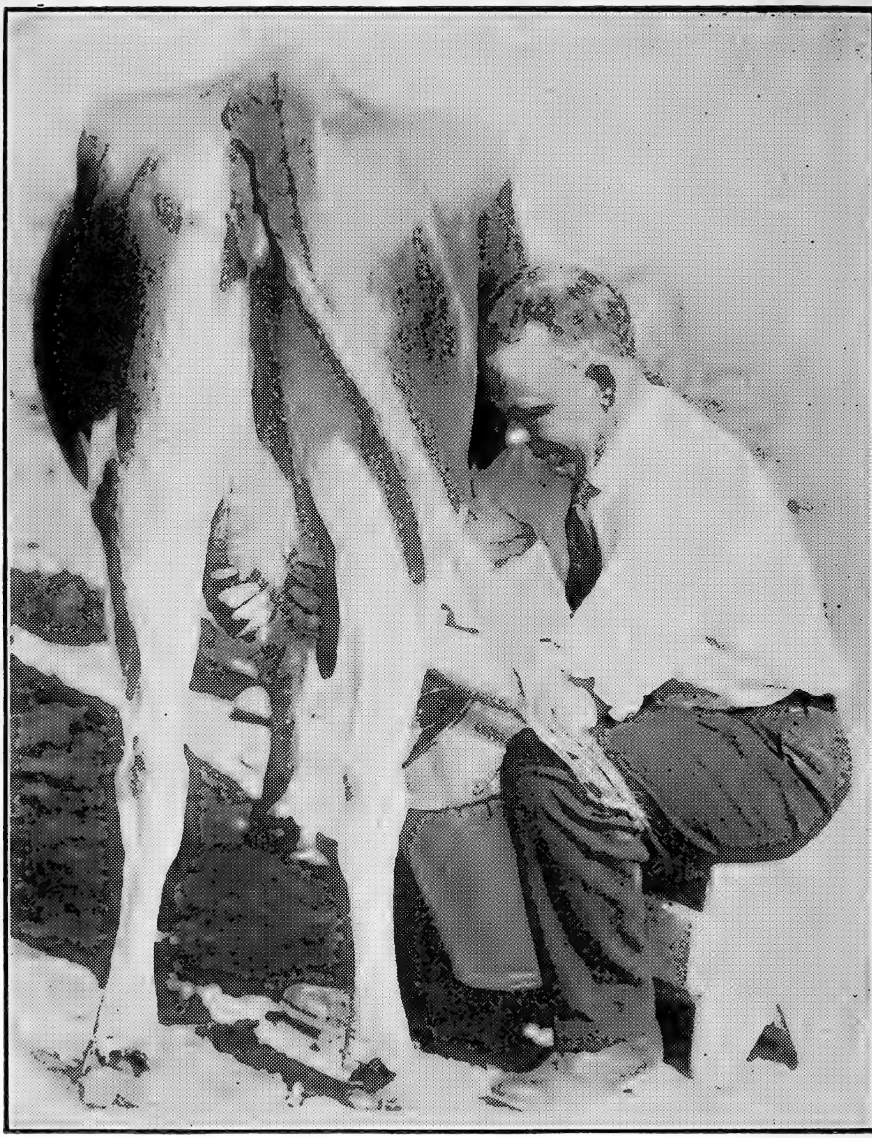


Figure C. Reaching as high as possible, the milker grasps the hind quarters and presses.

require the expenditure of but a few minutes as one becomes experienced in practicing them. The attempt should be to gently apply just enough pressure to every part of each quarter to massage thoroughly the entire udder. This stimulates the glands to further action and causes the secretion of additional milk.

With the use of the full hand the cow is again milked. Because the manipulations have encouraged the extra milk secreted to fill the

milk cisterns, milking is quickly done. If no further effort is made results such as the Hegelund method insure will be secured, but additional and even richer milk is yet available.

As illustrated by Figure D, the milker uses both hands in securing the few final strips from each teat. With one hand the udder, up close to the body, is grasped and pressed while with the other hand the milk encouraged by this movement is drawn. The same movements are practiced on each of the quarters.

Udder Manipulation Is Practical

The over-practical dairyman may insist that too much time, effort and theory are required for such a process of milking. The answer to this claim is that whatever is worth doing at all is worth doing well; that, when a milker becomes accustomed to the method, little or no more time is required to milk a cow than is required by haphazard milking and that, even though a minute or more is required, the extra amount of milk, and the richness of it, together with the persistency encouraged in the cow and the added development she attains, insure profit greater in most instances than the total profit secured from ordinary milking. That this is true has been conclusively proven by all experiments and experience.

On that day, when Germany crossed the Belgian border, the people of America entered upon a period different that any other they had ever experienced; a period when more than ever before they needed to look to that which has been wasted in the past for the profits of the future. The milk sacrificed by common milking is extravagant waste and in a large portion of instances measures the difference between profit and loss. With land, labor, feed, and cows high in price there can be no question as to the advisability of milking good cows, provided they are milked efficiently; otherwise, there is much doubt.

Most Objections Are False Ones

A further objection to the manipulation method of milking is that it is liable to cause cows to withold their milk at the first milking, awaiting the second milking. On the contrary, however, experiments show that the opposite is true. As the cow advances in lactation and becomes accustomed to this thorough milking, less milk is secured following the manipulations.

There may also be a belief that because the cow is so thoroughly milked at one milking she will give less at the next. In this instance, also, the opposite is true. The more the udder is massaged, provided it is gently done, the more the glands are stimulated and, because of the manipulation and the extra thorough milking occasioned thereby, the amount of milk secured at each succeeding milking will be greater than though the cow had been less thoroughly milked.

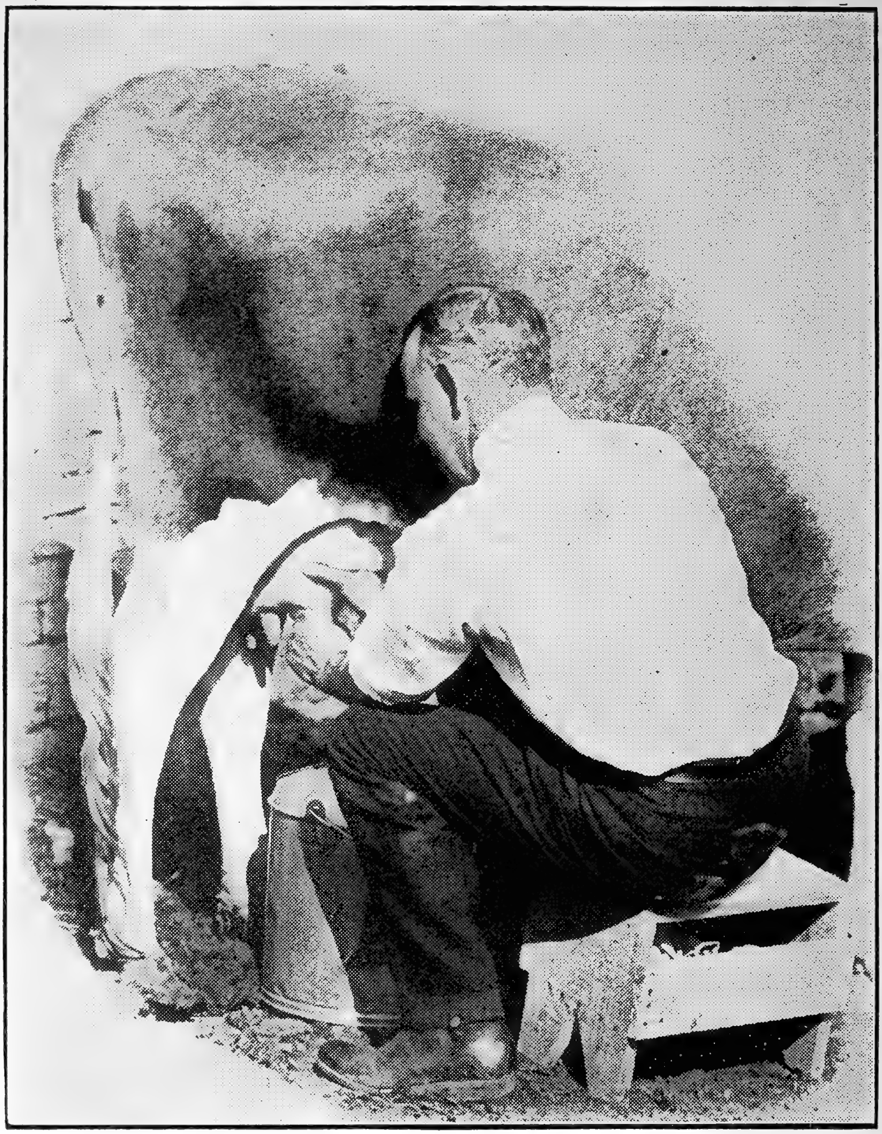


Figure D. Both hands are used in securng the final few strips from each teat.

Beneficial Effects Transmitted

Whether the beneficial effects upon the cow will be inherited by her offspring is a question of whether acquired characteristics are transmitted to the offspring. If so—and there is favorable reason for believing in the affirmative—the daughters of efficiently milked cows will be inherently greater producers and the sons of such cows will transmit the large producing characteristics to their daughters.

Udder Troubles Prevented

As a rule, the majority of udder troubles are due to inefficient milking. Blind quarters, uneven and unbalanced udders, as well as those diminutive in size, are caused by careless, haphazard milking. Very seldom indeed do udder troubles occur when cows are thoroughly milked and the udders massaged twice or oftener daily. As a matter of fact, it is well known that the best treatment that can be afforded an udder troubled with garget or other infection is thorough massaging and frequent and thorough milking. If for no other reason a methodical system of milking should be employed except for developing udders and keeping them shapely in form and in healthy, working condition, this reason would suffice to make it advisable.

Milking Becomes a Profession

Best of all, the milker becomes impressed with the fact that his duty is more than merely that of pulling teats. He becomes imbued with the importance of his work. He realizes that his mission is one of furnishing the most necessary of human foods. His job becomes a profession, and, realizing that he is accomplishing as useful and as necessary a mission as is any man in the world, the milking of cows ascends to a plane of dignity equal to any other phase of agriculture.

Useful Supplement to Machines

Gradually hand milking is giving way to machine milking, and where machines are used the udder manipulations are even more necessary. In most instances it will be found more advantageous in securing all the milk a cow yields, in encouraging her persistency and in avoiding udder troubles to massage the udder and permit the milking machine to do the stripping rather than to detach the machine and strip the udder by hand. It has seemed strange that manufacturers of milking machines have not carried on more exhaustive experiments along this line in an attempt to avoid after-milking cows by hand, but, great and successful as is the use of milking machines at the present time, the milking machine industry is yet in its infancy and much can be reasonably expected in the near future.

CHAPTER XXXIX.

CARE AND MANAGEMENT OF THE HERD BULL

If milk and butterfat production is considered merely on a temporary basis or from the viewpoint of what can be secured from day to day, it makes little difference how the bull is fed and cared for. But those who look far into the future with a determination to build up permanently the production of their herds know that the herd sire is a great essential factor in building up production from generation to generation.

Increased production, accomplished by improved methods of feeding cows and caring for them, amounts to little if it is offset by breeding the herd downward with inferior bulls or with good bulls improperly cared for. It is, therefore, essential that the services of only good bulls, properly fed and cared for, are employed.

When the bull is a year old he is ready for light service if he has been liberally and intelligently fed and well raised. At this time he should be considered as a herd sire, and no longer as a calf. He should be handled, cared for and fed as a bull at all times, that his usefulness and value will not only be conserved but increased. If a bull is good enough to begin using, he is good enough to use throughout his serviceable life unless his daughters when they come to milking age prove him a failure.

The usual custom of using a bull only two or three years and then sending him to slaughter is one of the most abominable practices, occasioning one of the most sinful and extravagant wastes, practiced by the American farmer, dairyman and breeders.

Inferior bulls should never be placed at the head of herds and, if by chance such a bull is found in service, he should be sent to the butcher at once; but the bull that proves himself capable of bettering the individuality and increasing the production of a herd should be prized highly, cared for properly and kept in service throughout his lifetime. This indicates that which is true—that no bull whose individuality and breeding denote that he should be a great sire should ever be destroyed until his true worth is known.

One reason why many good bulls are sacrificed is that a new bull is substituted to prevent inbreeding.

This is not a logical reason and is responsibly to a very large degree, for so many nondescript bulls being in service. If every good purebred, successful sire would be reserved by his owner to be used on his own granddaughters, one of the most successful plans of line-

breeding would thereby be inaugurated. A greater general improvement of the herds of this country would result from a wholesale application of this plan than from any other.

Dairymen object to paying what a really good bull is worth because they figure they can use him only two or three years and will then have to suffer a considerable financial loss when he must go to the butcher. Therefore, they purchase the kind of calves which will return them the original cost price, or nearly that much, when the butcher buys them. If, on the other hand, a herd sire was purchased with the understanding that he would be used for 10 or 12 years, the dairyman could see his way clear to purchase bulls of higher character that would improve his herd with certainty.

The only objections to this plan are that two bulls instead of one must be kept in service, that bulls become vicious, and, as they become old, their prepotency becomes impaired.

To build up a herd successfully, however, it is necessary to keep more than one bull in service, and it should be remembered that it costs less to keep an extra bull on the farm than it does to purchase new bulls often and run the chance of securing an occasional one that will tear down the improvement that former bulls have built up. Therefore, this objection needs no further discussion except the suggestion that community breeding, or two neighboring dairymen going together and using their bulls interchangeably, will solve in the best possible manner the problem of conserving exceptionally good bulls.

The question as to whether bulls become vicious or impotent depends almost entirely on the care, feed and management afforded them. Bulls do not become vicious, as a rule, unless viciousness is encouraged by mistreatment; and bulls do not become impotent, as a rule, unless impotency is encouraged by mismanagement or improper feeding.

When the bull is placed in service he should be given a roomy, light, comfortable, dry box stall that is always kept clean and well bedded. Such a stall should open into a paddock consisting of approximately one acre of ground fenced so strongly that the bull will never conceive the idea that it is possible for him to break out. Such a stall and paddock provide ample room for every necessity of the bull. The stall provides for protection and comfort and the paddock offers opportunity for sufficient exercise in the fresh air and sunshine to insure excellence of health.

The paddock fence should be made of heavy woven wire attached to strong, well set posts, and, if necessary, reinforced with barbed wire or planks. It should not be a tight board fence which places the bull in solitary confinement, for nothing tends more toward promoting viciousness in any animal than penning him up in such a way that he has no freedom whatever.

When the bull is yet young he should be trained. He should be treated kindly but firmly and taught to know and respect his master. A strong, smooth ring of copper or gunmetal should be placed in his nose and this should be examined occasionally and replaced with a new one at first indication of weakening. The first lesson the bull should be taught is that of permitting himself to be caught by the ring. Then, leading him to water once or twice daily and leading him out for service will quickly teach him that being caught by the ring and leading are not experiences to be dreaded. Unless he is abused at some time this training will last him as long as he lives, and, although he should always be led with a staff after he is more than a year old, he can always be handled with safety unless in some way or other he has become spoiled.

This system of management will also prevent impotency, provided the bull is not overworked. Never should he be permitted to serve a cow more than once at one heat period. Additional services make conception no more certain and needlessly overtax the sire. Seldom, if ever, is it necessary or advisable to use him more than once daily and, until he is 18 months old, two or three services a week are all that should be permitted. The following of this rule prohibits permitting the bull to run with the herd, a practice which is abominable in that it is dangerous, wears out useful breeding animals, causes them to become vicious and makes it impossible for the dairyman to keep a record of breeding dates, which is one of the great essentials in securing and raising calves successfully.

To prevent contagious disease and keep the bull in healthful breeding condition, the sheath should be thoroughly cleansed with a mild, non-irritating, efficient disinfecting solution following each service. This can best be accomplished by tying the bull following service and by the use of a large syringe, douching the sheath with two or three syringefuls of the solution. If care is taken to handle the bull gently and to make sure that the disinfectant solution is never too strong, it will be found to be a very simple as well as advisable operation to follow. In fact, where this plan is strictly adhered to, contagious abortion seldom makes it appearance, and in case it does it is quickly stamped from the herd. Where this plan is not followed it is almost impossible to get rid of contagious abortion, once it has attacked a herd.

Very often bulls—especially those that are allowed to wear their horns—molest fences and are difficult to catch. For these reasons it is not advisable to let them run loose, even in their paddocks. In such cases a strong wire cable may be tightly drawn from the front of the box stall to the far end of the paddock at a height such that a ring sliding on it when a chain connects it with the bull's ring, will just

pass under the top of the box stall door frame. This plan gives the bull almost as much freedom as though he were running loose, it provides him ample opportunity for exercise and yet it keeps him under the absolute control of his master. It is a plan which enables one to handle any bull, even though he may be inclined toward viciousness.

In fact, it is less difficult to preserve the usefulness of a bull which it is necessary to handle in this manner than it is one of a dull, sluggish nature, because the active bull will take daily exercise of his own accord sufficient to keep him in the best possible breeding condition, while the one of a more sluggish temperament will fail to do so. In the latter case, as such bulls attain age, exercise being so necessary to preserve potency, it will be found advisable to provide some system of exercise such as working the animal on a treadmill, leading him a mile or so daily, or placing in his paddock one or two younger bulls that will encourage him to take sufficient exercise.

Expressed in a few words, the care and management which sires should receive consist of keeping the bull under control and yet providing him with comfortable conditions and sufficient exercise, and preventing overservice. Where the attempt is made the ingenuity of man suffices to accomplish the desired end. By controlling the bull according to his individual requirements it is possible for his attendant to treat him with firmness and yet with kindness.

It should be remembered that bulls have minds of their own and use them. Seldom, if ever, will they attack their attendants when their attendants are alert and on guard. This is the reason why gentle bulls are the most dangerous. Mean bulls are always watched closely, but much confidence is placed in gentle bulls, with the result that invariably serious accidents are traced to gentle bulls carelessly handled rather than to active bulls carefully managed.

Because herd sires are kept for the purpose of transmitting their most valuable characteristics, it is essential that they be managed in such a way as to make this possible, and likewise it is necessary to feed them in such a manner that no valuable characteristic possessed by them will lie dormant and not be transmitted to their offspring.

Bulls should be kept in good condition, which is a state of being neither too fat nor too poor. If allowed to become emaciated their offspring will be deprived of many inherent qualities of excellence. On the other hand, if the bull is permitted to become overfat, and to remain that way for a considerable period of time, he is quite liable to become impotent and useless.

Until they have reached maturity, bulls should be fed rather liberally of a growing ration. An abundance of clover hay or other leguminous hays is advisable. Roots and silage may be fed but in amounts more limited than to dairy cows. Green soiling crops or

pasturage are always advisable when in season. An excellent growing ration is one consisting of two parts ground corn, two parts ground oats, two parts bran, and one part oil meal. This ration, or its equivalent composed by using similar feeds, is excellent for bulls of all ages.

When the bull has reached maturity it often becomes necessary to limit the amount of roughage to keep the animal in readily serviceable condition and, as a rule, when the bull has reached complete development very little grain is necessary to keep him in prime condition. Even as "the eye of the master fatteneth his cattle," so does the eye of the master determine by the condition of the bull the amount of roughage and grain he should have daily.

As in feeding cows, this can be determined in no other way except by a consideration of the individual. Some bulls can consume large volumes of roughage and yet remain in condition to serve promptly, while others become slow or even absolute failures if too much roughage is fed. Also, there are bulls which require, even after they have attained maturity, from 8 to 12 pounds of grain daily to keep them in the most thrifty and prepotent condition, while others, if fed more than four or five pounds of grain daily, become overfat, sluggish, and their years of usefulness are shortened.

On the average farm little consideration has in the past been given to the feed, care and treatment of bulls, although there is fast becoming a recognition of the fact that only the best of bulls should be used. Fortunate is the farmer, dairyman or breeder who succeeds in securing a bull, sufficiently well bred, good enough in individuality, and prepotent enough to transmit the best characteristics of himself and his ancestry to his offspring. This being true, the worth of such a bull should be recognized and he should be kept in that condition which will insure his greatest activity over the longest possible period of time. This can be accomplished only by surrounding him with treatment, care, feed and management that will maintain him from week to week and from year to year in the most thrifty, vigorous, healthful condition conducive to longevity and service.

CHAPTER XL.

THE CARE OF THE CALF

No discussion on feeding the dairy cow is complete unless it includes information relative to the feeding of calves. In fact, the factors most essential to success in dairying, as well as in breeding dairy cattle, are those pertaining to the use and care of good sires and the raising of calves properly and developing them into good cows.

Under the best of conditions it is doubtful if dairying can be made satisfactorily profitable from the standpoint of milk production alone. The one who prospers with dairy cattle is the one who feeds and cares for his cows so as to encourage large, economical production as a result, and then increases his profits by so raising the heifer calves, sired by good purebred sires, that they will grow into cows superior to their mothers. Such an one is able to sell, each year, nearly half of his cows, filling their stalls with heifers that have grown to cowhood under conditions most conducive to profitable production. Such an one is more than a dairyman. He is a breeder, and, even though he milks only grade cows, he finds much pride and profit in building better herds generation after generation. He is not the one who says: "I milk just grade cows; therefore, I need only a cheap bull," for he soon learns that quite as good a bull is needed for building up a herd of grades as is needed for building up a herd of purebreds.

Very recently an illustration in proof of this statement came to my attention. Six years ago a young man in northern Iowa began dairying with just good grade cows. He used the best sires he could procure, consecutively, raised the calves well and, as they reached cowhood, placed them in the stalls from which their less desirable mothers had been sold. His neighbor, an older man, started breeding purebred cattle 25 years ago. He was careless about the sires he used and failed to raise his calves well. The dairyman decided to sell his grades and go into the purebred business. At the same time the breeder decided to sell his purebreds and quit. Buyers visited both farms. They paid $111 a head for the grades and $100 a head for the purebreds.

In one instance the owner, although his females were all grades, was a breeder as well as a dairyman. In the other instance the owner, although all of his cattle were purebreds, was just a dairyman. The one was prosperous. His cattle had made him a small fortune in six years. In fact, I dare say he made more profit and obtained more real enjoyment from his cattle in six years than his neighbor did in 25 years.

Counterparts of this illustration are plentiful. Some men breed up, others down. And so it must be apparent to the reader that, to obtain real success and pleasure from dairying, it is necessary not only to feed and care for cows properly; it is necessary to use good, well bred and well cared for bulls always and then to raise the calves properly.

Profits will result, as a rule, from milk production, but more and surer profits will come from the sale of cows whose places are to be filled with daughters which each generation are better than were their mothers.

Given strong, healthy, vigorous calves at birth, the problem of calf rearing is not a difficult one. In herds where both cows and sires have been fed and cared for according to suggestions given in previous chapters calves will come exceedingly strong, healthy, vigorous and well formed. At birth the desirable characteristics of their ancestors will be dominant, for they have been well developed by feeding the calf prior to birth through its mother, and, because the sire was in most potent condition, his characteristics and those of his ancestors will assert themselves.

When the cow gives birth to the calf, she transfers to man the obligation of further developing the desirable characteristics and the growth of the youngster. For the sake of the cow as well as of the calf it is advisable for the attendant to be present during the process of parturition. Assistance in delivery is sometimes necessary. Occasionally a calf comes with phlegm in its nostrils or throat or with a membrane over its nostrils. These must be removed at once, for, as soon as the umbilical cord is broken, the calf must start breathing promptly or smother. Such a membrane is easily removed from the nostrils by hand and such phlegm as may be in the throat can be easily removed by opening the calf's mouth and blowing in it. Sometimes, too, especially in the case of young heifers, the mother is liable to abuse the calf and she has been known to hook or tramp the infant to death. Every such obstacle can be overcome by the attendant being present at parturition time, which is especially advisable where the calves are prized highly.

As soon as the calf is born and starts breathing, the umbilical cord should be thoroughly disinfected by rubbing it well with a 5 per cent solution of efficient disinfectant. This is so important that it should become a rule followed strictly on every dairy farm. A large percentage of calf diseases, such as white scours, hemorrhagic septicaemia, etc., result from open wound infections. The most prolific source of such infections is the open umbilical cord which has not been disinfected. By becoming infected at the time of birth or shortly following, the germs begin multiplying but may not assert themselves

until several weeks later, when the calf becomes ill and dies before the trouble can be diagnosed or the life of the calf saved. It is well to disinfect the umbilical cord or, better, the entire navel, twice daily until the umbilical cord has become thoroughly sealed. There are some who practice tying a strong cord, thoroughly saturated with disinfectant solution, around the umbilical cord as close to the body as possible. The only objection to this method is that complete drainage of the umbilical cord is prohibited if the cord is tied tightly, but the advantage is that one application of disinfectant solution to the navel suffices.

It is customary to leave the calf with the mother for the first 48 hours. This is permissible provided the udder and teats of the cow are kept clean so that the calf does not take dirt, germs and foreign substances that may stick to the teat, into its stomach. Some calves are lost in this way when their lives could be saved by feeding them with their mothers' milk right from the start. There is just enough liability of bowel infection occurring from nursing the mother that freshens in a stall, so that the extra precaution is recommended of taking the calf away from the mother even before it has nursed at all. By so doing, the calf is more easily taught to drink than though left with the cow to nurse a few times. On the other hand, the youngster aids greatly in relieving inflammation which may be present in the udder and, by remaining with its mother, it is afforded milk of proper temperature and at sufficiently frequent intervals in the most convenient manner. The plan is, therefore, permissible, provided the udder and teats of the cow are kept clean.

When the calf is taken from the cow, it should be placed in a box stall that is kept scrupulously clean and well bedded. It should be warm, well lighted and well ventilated. Calves placed in stalls that are damp, dirty, dark and poorly ventilated cannot be expected to live. It is so easy to admit sunshine and fresh air into the calf stall and it is so easy to keep the stall dry, clean and well bedded that there is no excuse for keeping a calf in any other kind of stall. So much depends upon this one factor that, unless suitable quarters of this sort are arranged, there is little use trying to raise calves successfully. It cannot be done.

Teaching the calf to drink is a very simple task and demands no discussion except to state that the calf should be permitted to become hungry and then patiently encouraged to drink.

Both overfeeding and underfeeding cause trouble. If overfed the calf scours. If underfed it becomes weak and quickly succumbs to any sickness that may attack it. Therefore, the feeder should carefully consider the amount of milk the calf should have and vary the amount with the different calves according to their size and vigor.

While young the calf should be fed at least three times daily. Two pounds at a feed three times a day will suffice at first, and this amount can gradually be increased, watching each day to detect any indication of approaching scours.

Calves vary so greatly in their digestive capacities, which govern the amount of milk they should have, that no hard and fast rules can be given. As in feeding cows, the feeder must govern his operations by catering to the individuality of the animal. This requires the use of scales. A large percentage of calf trouble could be eliminated if the feeder would weigh the milk given the calf and not increase by amounts larger than one-half pound in any one day. By so doing and by watching closely the condition of the calf, any intelligent feeder can determine for himself better than anyone else can determine for him how much milk the calf should have.

Temperature of Milk

Even as scales are necessary in determining the amount of milk a calf should have, so is a floating thermometer (which can be secured from any dairy supply house cheaply) necessary in providing milk of the proper temperature. Calves fed warm milk one day and cold milk the next do not thrive. More often they die. Nature has provided for calves to take milk directly from the teat of the cow and to secure it at body temperature, which ranges from 98 to 101 degrees Fahrenheit. Not only should milk be fed at a temperature corresponding, but it should be fed at the same temperature each time. This can be accomplished by milking the cow and taking the milk direct to the calf, but it can be better done by the use of a floating thermometer.

Quality of Milk

R. M. Washburn has recently completed very extensive experiments to determine the proper richness of milk for feeding young animals. These experiments show with much conclusiveness that the best richness to feed is 2½ per cent. The matter of which breed furnishes the milk is shown to be of little importance. It is indicated that by standardizing rich milk, either by separating and taking away part of the butterfat or by adding skim-milk to reduce the test to a richness of 2½ per cent, the best of results may be expected provided the milk is fed at the right temperature. The feeding of over-rich milk tends to cause the animal to become overfat at the expense of growth, or to scour.

Cleanliness

All feeders know so well that feeding utensils should be kept scrupulously clean that this phase of the subject should need little or no discussion. Suffice to say that if pails are not thoroughly cleansed and sterilized by rinsing with scalding water or by subjecting them to

steam, bacteria multiply and trouble follows. In fact, cleanliness, regularity and proper temperatures are the three factors which are absolutely essential in successful calf raising. Dirt, irregularities, and adverse temperatures cause more trouble in raising calves than all other factors combined.

Feeding Grain

When the calf is a few days old it will begin eating grain. Then, if allowed to run with other calves, a little stanchion and feed box should be provided for it so that, immediately after it has drunk its milk, it may be securely fastened and encouraged to eat grain which may consist of two parts oats, two parts corn, two parts bran and one part oil meal, or any ration of this character composed of feeds upon which calves thrive. It is advisable to encourage calves to eat grain at the earliest possible date, for, by tying them up immediately after they drink their milk and instilling in them the habit of eating grain at once, the pernicious habit of sucking each other's ears and teats is overcome. The principal cause for heifers freshening with uneven udders and blind quarters is that when they are young they are permitted to be sucked. This is also the reason why cows oftentimes suck themselves or each other. Moreover, when calves begin eating dry feed the danger of scours is minimized and the calves grow more rapidly and become more thrifty and vigorous.

Feeding Hay

In raising calves it is quite as essential that their digestive apparatus be developed and distended as it is that growth be promoted. To accomplish this, it is advisable to encourage the eating of much roughage. It is surprising how large an amount of bright, well cured clover hay calves will eat if the opportunity is afforded. As soon as the calves begin eating grain, good clover hay should be put before them at regular intervals so that twice daily they may eat all they desire. Clover hay is specified because it contains the growing materials calves need, and seemingly they thrive much better on clover hay than they do on timothy or alfalfa. If fed alfalfa hay they are liable to be affected with scours.

Feeding Silage

While calves are young, it is not advisable to feed them largely with silage. They secure succulence from the milk, and experience teaches that by withholding further succulence the youngsters are encouraged to eat more largely of grain and hay, which results in greater and more rapid development.

Exercise

As indicated before, sunshine and fresh air are essential. Also it is well for calves to be permitted to exercise at will. Therefore, dur-

ing the warm portions of days in winter and the cool portions of days in summer, it is well to permit calves to be out in the open where they may exercise freely and take advantage of all the sunshine and fresh air that is available.

Pasturing

If the calf is born in the fall and wintered properly it should be allowed the run of a small pasture or grass paddock during the summer. The grass must not be depended upon, however, to supply all of the food the calf needs. Grass is largely water and the young calf can hardly eat enough to secure sufficient nutrients for proper growth. It is, therefore, well to continue feeding grain through the first summer and, when the grass becomes dry and short, it is advisable to offer the youngster dry hay once or twice daily. By so doing growth and development continue in a satisfactory manner. Otherwise the animal ceases to grow, becomes stunted and does not develop into the excellent cow it should become.

There are those who contend that young calves should not be pastured the first summer. The reasons substantiating their claim are that the calf's stomach is not large enough so that sufficient grass can be eaten to supply the needs of the youngster, and that hot weather and flies are more detrimental to calves than to older animals. These objections, however, may be overcome by keeping calves in cool, darkened, dry, well ventilated quarters, free from flies in the daytime, feeding them hay and grain in amounts such as they will clean up readily, and allowing them to go to pasture during the hours of darkness. It is surprising what a large amount of hay calves will eat under this system of management and how excellently they will thrive.

Bearing in mind that the manner in which a calf grows during its first year determines to a large extent its excellence at maturity, the wise dairyman and the breeder will take particular pains to so manage the youngsters that they will grow with regularity every day. To accomplish this necessitates keeping the calves under conditions that are comfortable and healthful and supplying proper foods in sufficient abundance so that the digestive apparatus will be kept in most efficient condition and at all times distended to the extent that most excellent development is assured.

Feeding Skim-milk

All calves should be kept upon whole-milk for the first two weeks. It is during this period that greatest difficulty is experienced from such troubles as scours, calf cholera, pneumonia, etc.

Calves born healthy and strong are not born to die and, regardless of what breed they belong to, they can be successfully raised if a definite, advisable system of regular care and treatment is provided.

There is no other phase of dairying which requires so much skill, so much patience and so much judgment as the feeding of young calves.

The first and most important essential is that the quarters where calves are stationed be free from germ life. This necessitates the stalls being cleaned and bedded daily and disinfectants being used freely that every nook and corner, which under careless conditions harbor disease-producing germs, be cleaned and disinfected regularly.

When the calf is two weeks old, if the opportunity is granted, it will begin nibbling hay and grain. It should be encouraged in this venture because, as soon as a liberal amount of roughage and grain is eaten by the calf, the likelihood of scours is greatly lessened. It is then time to begin changing the calf from whole-milk to skim-milk. This should be done very gradually. Two weeks should be taken in changing the calf onto a complete ration of skim-milk. Moreover, the skim-milk added to the whole-milk should be of the same temperature as the whole-milk, or 98 degrees Fahrenheit. Feeding chilled milk to baby calves is enough to cause scours. Every day the calf scours its growth is checked and it should be remembered that, once a calf begins scouring, it is more susceptible to digestional disorders in the future. Very often one case of scours is sufficient to take the life of a youngster.

While the change is being made from new milk to skim-milk the liquid ration should not be increased because feeding an extra amount of skim-milk will not take the place of the butterfat removed from the whole-milk, and time enough awaits to increase the amount given after the calf has successfully been transferred to a complete ration of skim-milk.

The foam which rises on top of skim-milk as it comes from the separator should not be given to small calves. It causes them to bloat and this often terminates in scours.

After the calf is on a complete ration of skim-milk it is advisable to increase the amount given very gradually, being careful never to overfeed. The amount of skim-milk varies according to the size, strength and condition of the calf, and this can be determined only by the feeder who learns by studying each individual calf. There is no better feed than skim-milk for young animals, so that it should be used as largely as possible and its use continued for six months, or even longer, if an economical supply is available.

As a precaution against scours and for providing bone and muscle-growing material in the most digestible form, blood meal, or, better, blood flour, which can be secured from all large packing concerns, may be used to excellent advantage by putting a teaspoonful in the calf's milk and gradually increasing this so that when the calf is six weeks old it will be receiving a tablespoonful with each portion of milk it drinks.

Skim-milk already rich in protein will be rendered richer in this respect, which makes it even more advisable to feed freely of a grain ration supplying carbohydrates and fat, as corn, oats and oil meal do.

Buttermilk

This by-product, being of practically the same composition as skim-milk, will produce as good results in raising calves as will skim-milk. More care is necessary in teaching calves to drink buttermilk because it is sour, but, if it is gradually substituted, as it and skim-milk should be, calves will take kindly to it, make just as good growth and be even less subject to scours than though they were fed skim-milk. Care, of course, should be taken to feed the buttermilk at each feeding period in a condition as nearly uniform in acidity as possible.

A precaution that should be taken in feeding milk to calves is to make sure the milk is not infected with the disease germs of tuberculosis, white scours, or contagious abortion.

Skim-milk or buttermilk secured from sources that permit the mixing of milk from many herds, or where milk is fed from a herd suspected of being affected with either tuberculosis or contagious abortion, should be thoroughly pasteurized before feeding. There is no method by which a clean herd can be developed from a diseased herd with certainty unless this precaution is followed.

Water

Some calf raisers erroneously believe that because calves have milk to drink they need no water. As a matter of fact, when given the opportunity and provided with clean water of suitable temperature, calves drink large amounts and thrive accordingly. They will not grow satisfactorily unless they are thus provided for.

Calf Meals

There are many very excellent calf meals on the market which can be purchased at prices warranting their use.

The manufacturers of these feeds have given the subject of calf feeding careful study because the success of their business depends upon the excellence of the results that may be secured when their feeds are put to practical use.

For this reason the directions of the manufacturers should be followed to the letter when their feeds are used, and if this is done there is no doubt that additional gain in growth and condition may be expected.

Where whole-milk is sold, the problem of raising calves is more difficult and it is then that calf meals are absolutely essential. In the beginning they should be used with whole-milk, which can be gradually eliminated by substituting warm water in its place.

Experience shows that very excellent calves can be raised in this manner, especially when they are well fed and given hay in addition.

Also, whey resulting from cheesemaking can be used to advantage when the nutrients that have been taken away are replaced with calf meal of a suitable character.

It cannot be expected that calves will look as sleek and fat when they are raised on calf meals and warm water or whey, but the scales will show that the calf is making almost, if not quite, as large growth. Where special pains are taken it will be found that at maturity the calves will have developed into just as good cows, as large in size and as excellent in dairy proclivities as though they had been raised on milk, and the cost of raising them will have been considerably less, except where an abundance of skim-milk is available.

Calf Scours

Even when most careful attention is given to the feeding and care of calves, scours sometimes occur. Upon the first indication immediate attempts should be made to check the disease. The amount of milk should be reduced and two or three ounces of castor oil given the calf by pouring it on the root of the tongue. If this is done soon enough and the milk ration reduced no further trouble should be experienced.

If the scours do continue a solution composed of one-half ounce of formalin in 15½ ounces of water should be provided and one teaspoonful for each pound of milk fed should be given until scouring ceases.

An excellent remedy for curing severe cases of scours is as follows: One ounce bismuth subnitrate, one ounce salol and three ounces bicarbonate of soda given at the rate of one teaspoonful three or four times per day in three ounces of milk as a drench. Usually the treatment will check the most serious case of common scours in a day or two.

Such remedies, however, should not be depended upon, for it should be remembered that preventing scours by careful, regular management is the real secret of successful calf raising.

White Scours

This variety of scours is one of the most serious diseases affecting calves. It attacks the infant shortly after birth and is usually fatal. Prevention by disinfecting the navel cord as soon as the calf is born and keeping the cord properly sterilized in this manner is the best precaution against this deadly disease.

As soon as a case is noted in the herd the affected calf should be isolated, and all milking utensils and calf pens thoroughly cleansed and disinfected, so that the disease will not spread through the herd.

Some times the formalin or the bismuth-salol treatment recommended previously will aid in checking white scours but prevention and isolation are more to be trusted.

Pneumonia

The death loss from pneumonia in young calves is much larger than is usually believed because the trouble is not diagnosed properly.

Pneumonia results from improper ventilation of the calf barn, from permitting drafts and from exposure occasioned by radical changes of temperature.

Pneumonia can be absolutely prevented by keeping calves in warm, dry, well ventilated quarters and giving them access to warm, fresh air and sunshine.

Calves attacked by pneumonia lose their appetites, breathe hard, become fevered, a rattle can be heard in the lungs, and there is usually a discharge from the nostrils.

Pneumonia is often infectious. An affected calf should at once be removed from the herd, and stalls cleaned and thoroughly disinfected. Cold compresses should be placed over the lungs, an abundance of fresh air supplied, and the bowels should be kept in laxative condition. A mustard plaster application is the best additional treatment to be suggested, and as a rule these precautions carefully and diligently followed will save the life of the calf, which otherwise will certainly be lost.

Calf Colic

Overfeeding, giving milk of different temperatures or subjecting calves to cold drafts causes calf colic, which results in violent pains in the stomach. The calf when attacked becomes restless, and oftentimes kicks and bawls. If the colic is severe prostration follows and in a short time the calf dies unless aid is given.

An excellent preventive of calf colic is an always available supply of salt and charcoal, mixed one part of the former and two parts of the latter. This may be kept in a frequently cleaned box in the calf stall, and where it is offered in this manner it will be surprising what a large amount of charcoal and salt is eaten by calves.

For the calf that becomes colicky a prescription should be provided consisting of a teaspoonful of turpentine and a tablespoonful of raw linseed oil. This mixture should be given as a drench every two hours until the calf regains normal condition, but, as a rule, one dose will suffice.

Blackleg

This disease affects cattle under two years of age, but usually calves under one year old. All cattle men are familiar with the characteristics of blackleg and realize that it is more prevalent in certain sections than in others.

The only safe and certain method of prevention, as well as the most economical method, is to vaccinate calves against the disease.

The general belief is that calves are more susceptible to blackleg if they are thriving especially well or if, after thriving especially well, they are permitted to decline in condition rapidly.

Dehorning Young Calves

Breeders of purebred cattle as a rule do not favor dehorning calves. They much prefer to train the horns while the calf is young in the manner most acceptable to the particular breed being raised. There is no doubt that the elimination of horns decreases the selling price of most breeds of dairy cattle because a well trained pair of proper-sized horns undoubtedly adds to the general appearance.

Where dehorning is advisable, it should be done while calves are young. When two weeks of age a small button may be felt just breaking through the skin on the young calf's head. At this time, after clipping the hair from around the button and saturating the surrounding skin with oil or grease to prevent it being burned, caustic potash may be applied.

Care being taken to wrap the stick of caustic so the fingers will not be burned, the button should be rubbed vigorously, making sure that the application is sufficiently thorough that scars or stunted, ugly horns will not result.

For two or three days care should be taken to prevent the calf from getting its head wet, for this will cause the caustic to run down over the face and possibly into the eyes with serious results.

Caustic potash will not remove horns at a later date, unless by the use of a knife the horny covering is removed. This can be done even when the calf is a month old, but applying the treatment at the age of 10 days or two weeks is much more successful and much simpler

Lice

Calves infested with lice do not thrive. Frequent examinations should be made to make sure lice are not present on the calves or in the barn.

If lice are discovered the first thing to do is to get entirely rid of them.

This necessitates a complete cleaning of the barn and the disinfection of it by thoroughly spraying every crack and corner with a 5 per cent solution of coal tar dip. The calves should be washed with a solution of coal tar disinfectant ranging in strength from 3 to 5 per cent. If this is done in cold weather the calves should be rubbed with dry cloths and kept blanketed until dry to prevent their catching cold. Crude oil may be used instead of coal tar disinfectant by carefully and thoroughly rubbing it over every portion of the body.

These treatments will not kill the nits or eggs that may be present so that the barn disinfection and the treatment of the calves must be repeated in seven or eight days. In this manner the calves and the premises can be rid of these abominable growth destroyers.

Ringworm

It is not at all uncommon for calves to be troubled with ringworm. If left to run its course it will eventually disappear, but in the meantime the calf is rendered uncomfortable and unsightly.

By washing the affected parts of the skin and applying a liquid made by dissolving two ounces of sulphate of copper in one gallon of boiling water, or by painting the affected part of the skin with tincture of iodine the ringworm will be promptly removed.

Warts

The appearance of warts on calves is of great frequency. The objection to them is that they are unsightly, although there is no evidence that they affect the growth of the calf or cause other disturbances. However, it is best to get rid of them and there are many ways of doing so.

Large warts should be twisted off with the fingers or cut off with a scissors, and the roots should be cauterized or painted with iodine. If this fails to kill them, a more severe treatment will be necessary. The skin and hair surrounding the warts should be greased and the warts burned off by touching them with a feather or swab saturated in nitric acid or sulphuric acid.

Whichever treatment is adopted, two or three applications may be necessary, and when the wart is killed the scar should be treated with lard or carbolated vaseline to soften it and hasten the growth of hair.

On parts where such severe treatment is not possible, a mixture of one part salicylic acid and seven parts collodion should be painted on the warts and allowed to dry. In two or three days the dead scabs should be removed and the warts again treated. By following this treatment the warts will soon disappear without injuring the animal in any way.

Removing Extra Teats

When the calf is very young examination should be made of the udder and teats. Occasionally calves are found which have two teats grown together or "webbed." Such calves cannot successfully be treated and will never grow into satisfactory cows. They should be vealed for they will be good for neither milking nor breeding purposes.

Occasionally a rudimentary teat is found growing on one of the regular teats. If the calf is allowed to grow to cowhood without treat-

ment the result is serious. The cow gives milk out of the rudimentary as well as from the end of the teat and, even if the influence is not adverse in other respects, it certainly makes milking the cow very disagreeable and it is impossible to milk her by hand in a sanitary manner. If such a rudimentary appears on a teat it should be clipped off close to the teat with a pair of sharp scissors and the wound cauterized with caustic potash. It will then heal and give no further trouble.

More often rudimentary teats are found growing between the teats and on the rear of the udder. These are not harmful except that they detract from the appearance of the cow and serve no useful purpose. Therefore, these rudimentary teats should be removed. They can easily be clipped off with sharp scissors and the wound cauterized or a silk thread may be tied tightly around them close to their attachment and they will soon disappear.

Separate the Calves

At the age of three or four months male and female calves should be placed in separate lots. If kept divided in this manner all danger of accidental breeding is avoided. Otherwise an occasional heifer becomes pregnant at so early an age as to handicap her future usefulness.

Other than this division of the calves, it will be found better to allow several calves to run and feed together. The experienced herdsman knows that calves eat better, take more exercise and seem to thrive better where two or more calves live together than where one lives alone.

Weaning

At the age of six or seven months, or sooner if there is a scarcity of skim-milk, calves may be weaned. If they have been encouraged to do so, they will be feeding well on hay, grain, grass, or silage and roots when this age is reached and they will not greatly miss the milk.

They should continue to receive good care, however, and be fed so abundantly that growth and development will not be sacrified for even a day until they have reached cowhood.

Fall Calves Best

Not only for the sake of large and profitable production on the part of the cow should calves be born in the fall, but circumstances are such that in behalf of the calf itself it is better that it be born in the fall rather than at any other season of the year.

The fall-born calf passes its first six months of life while on milk during that portion of the year when it can be kept indoors and when time permits giving it the very best care. By the time grass comes it is ready to wean and large enough to take exercise on luxuriant

pastures when heat and flies are not severe and to be kept very cheaply by an additional small amount of grain and hay. By the time the calf is a year old and ready to enter winter quarters it has made sufficient growth so that it can be wintered the second year very cheaply on clover hay, silage, corn stover, and other roughages with a small amount of concentrated feed of a character and in such quantity as will balance the roughage and keep the yearling growing until grass comes again. It can then be turned to pasture and required to shift largely for itself as long as pastures are good.

Breeding

Heifers of the smaller breeds should be bred to freshen at the age of 24 months. If they were born in the fall they will freshen the second fall following, which is a distinct advantage. Heifers of the larger breeds should not be bred until they are 18 months of age. When heifers approach freshening they should be handled in identically the same manner as has been advised for preparing cows to freshen. Then they will come into cowhood with udders well developed and be ready to yield profitably with first calf.

It is even more essential that an attendant be present when the heifer freshens than it is when older cows freshen.

For some reason or other, heifers seem to become unduly excited when the calf is born and it is not uncommon for them to bawl, paw their bedding and handle the calf very roughly, oftentimes going so far as to trample the calf to death. If the attendant is present, he can quiet the heifer and if necessary, remove the calf to another stall and thus save its life.

It is needless to say that in breaking heifers to milk the milker should be quiet and handle the young mother gently, even though she may be inclined to kick and otherwise object to being milked. Harsh, cruel treatment at this time is liable to ruin the heifer as a milk cow for life, while patient and gentle handling will show her that she is not to be harmed and she will quickly reconcile herself to giving her milk freely.

Some heifers and cows refuse to give their milk when the calf is first taken from them. When this is the case, the trouble can be rectified by placing the calf in a stall where the cow can see it. She will then give her milk without further trouble.

The First Lactation Period

The question of how good a cow the heifer is to develop into is largely a question of how well she is handled during her first lactation period. Even as speed is developed in trotting-bred horses by requiring them to trot as fast as they can without harming their future usefulness, even while young, so is milk production encouraged

in the cow bred for milk by requiring her to yield as largely as possible without injuring her future usefulness, even when she is young.

Therefore, it is advisable to start the heifer on a small ration of about five pounds of concentrates in addition to her roughage when she has been fresh from two to four days and, by increasing her ration one-half pound every day as advised in bringing an older cow to her milk, she is encouraged to give her maximum flow of milk when she has been fresh about 30 days.

Then, if the cow is fed an abundant, well balanced ration, kept in just good, thrifty condition and encouraged to milk persistently throughout the year, being aided in doing so by surrounding her with comfortable environment during the entire year, she will develop the habit of persistency and each year following she will respond to proper care and feed and milk largely and persistently.

Cost of Raising Calves

To properly raise a calf from birth to milking age requires much intelligent judgment, labor and expense. This is true in normal times and it is doubly true in war times. Various experiments have been performed and accurate accounts kept by various experimenters to determine the exact cost of raising a calf to the age of two years, and all seem to agree that, where exact records are kept of every expense, as should be the case, the cost ranges from $60 to $75.

The following table compiled by Dr. Lindsey from the experiments of Bennett, Cooper and Trueman shows the cost other than for food of a two-year-old heifer:

	Bennett & Cooper	Trueman
Labor	$8.00	$10.00
Interest on value of heifer	3.65	
Interest on buildings	2.38	
Interest on equipment	.55	
Bedding	3.00	2.00
General expense	2.93	4.00
Total	$20.51	$16.00

With labor as scarce and expensive as it is at the present time, the above charges will be found to be quite conservative.

Dr. Lindsey presents an additional table which includes cost other than for food and has compiled the following table which shows the total net cost of a well fed heifer raised to the age of two years:

	Bennett & Cooper (Wisconsin)	Trueman (Connecticut)	Lindsey (Mass.)
Initial value of heifer	$ 7.00	$ 4.00*	$ 4.00
Food cost	40.83	55.00	57.73
Other costs	20.51	16.00	20.51
Total	68.34	75.00	82.00
Credit by manure	8.00	5.00	8.00
Total net cost	$60.34	$70.00	$74.24

*Added by Lindsey.

This definite information, showing the cost of raising a heifer to be more than is generally realized, should not prove to be a discouragement and cause dairymen to believe they cannot afford to raise heifer calves. On the contrary, the information should impress them with the true value of their heifers and cows and cause them to think seriously regarding the kind of heifer calves they will raise in the future.

It costs no more to raise a good heifer calf than a poor one and very little less to raise a stunted, worthless calf than one that is vigorous, well grown and possessed of its real inherent dairy qualities to the extent that it will be worth its cost of raising and more when it reaches cowhood.

No better argument could be cited in proof of the advisability of using only good, purebred sires from highly productive ancestry.

It is not uncommon to hear dairymen state that they cannot purchase as good cows as they can raise, and the statement is very true. It is the height of folly for a dairyman who has been in business for years to be compelled to depend upon purchasing cows or to be content with milking cows of a mediocre sort.

The question is often asked, "Where can I secure good cows?" The answer is self-evident, and there is only one logical answer. It is, "Breed and raise them." The one who depends solely upon milk production for his profit is not likely to fare extra well over a long period of years. He who is sufficiently thoughtful to see into the future and to know what good cows he can breed, raise and develop by using only the best sires, raising the heifer calves by the most acceptable methods and developing their dairy characteristics so that they will prove more efficient milk producers than their mothers, will invariably find that the most profitable phase of dairying results from the surplus cows he has for sale each year.

No better plan can be followed by the dairyman or breeder than that of using such excellent sires, raising and developing his heifers so well that each generation finds his herd more productive than it was the generation before. This enables him to sell each year his older cows, keep the younger ones and breed upward.

This is not only the profitable plan, but it is the system which adds pleasure to dairying. There is no man so devoid of pride but that he will be highly gratified if, after dairying for a number of years, he can go into his barn and find there a herd of cows such that no herd is superior and every one of them bred, raised and developed by himself. This is not only possible; it is practical; and is but the certain result of systematic, intelligent breeding. When it is so evident that superior, highly profitable cows can be bred from mediocre ones merely by the use of good sires and satisfactory methods of care, feed

and management, the one who contents himself with continuously milking common, lowly productive cows throughout a lifetime writes his own indictment. If it were necessary it would be excusable. Because it is not necessary and because good herds can be developed merely by adding thought and intelligent effort with scarcely no additional expense, there can be no logical excuse for not building up a herd superior in productivity and uniformity of type and conformation.

Raising Bull Calves

He who is a good enough breeder to raise service bulls for others should be proud of his vocation. There is no more laudable occupation than the breeding and raising of sires that will aid others in building their herds better. On the other hand, he who raises bull calves from grade cows, or even from poor purebred cows, in either event sired by poorly bred sires, and then passes them on to breed some one else's herd downward is an undesirable citizen.

Therefore, bull calves that are not really fit for reproducing their own likenesses and the likenesses of their ancestors should be vealed as early in life as possible. It is unprofitable to raise them for beef if they are dairy bred and statistics show that, under conditions which have existed for the past several years, it is not profitable to raise them for beef even though they are beef bred unless especially favorable conditions for beef cattle raising and feeding exist on the farm.

If the calf is well bred and a good individual it should be raised and placed where it can serve in bettering the production of a dairy herd.

Bull calves are raised quite like heifer calves until they are six or eight months of age. Then the time comes when they realize their sex. Bull rings should be placed in the youngsters' noses and training should begin that they will be well mannered fellows as far as manners can be educated into bulls. They should be taught to lead. This is usually accomplished by taking them to water with a lead rope instead of driving them. Bulls, even when young, should be handled firmly, but not roughly. It is a mistake to unnecessarily abuse bulls, for this generates in them an antagonistic temperament and causes them to become unruly. One should never play with bulls, even when they are calves; neither should one go to the other extreme and abuse them.

It is well to tie the calves up at the age of six or eight months to teach them that they can be handled and that they do possess a master determined to control them. Bulls, like heifers, should be kept thriving and growing from birth to serviceable age.

When a year old light service may be given them. One or two cows a week with only one service for each is as heavy as they should be worked at first.

By feeding him well and keeping him growing the bull may be put into regular service at the age of 18 months, provided he is kept away from the regular herd and permitted to serve each cow only once.

The most ruinous practice, and one which undoubtedly accounts for many of the mediocre animals sired by purebred sires, is permitting the bull to run with the herd. Not only does this result in poor offspring, but it uselessly wears out the sire that would remain serviceable many years longer if he was intelligently handled.

When the young bull goes into service his care, feed and management should be the same as that described in a previous chapter for service bulls.

When raised for sale the bull should be raised in identically the same way as the one which is to be retained on the farm for service, and when selling time comes he should be in the best possible condition, so that he will please the prospective buyer and later prove satisfactory, producing for his purchaser offspring better than the cows to which he is bred.

CHAPTER XLI.

FITTING ANIMALS FOR SALE

Health, large production, rapid growth, complete development and regularity of reproduction are the factors uppermost in the consideration of the breeder and dairyman as they conduct the daily operations incident to care, feed and management of cattle.

The successful one, however, cannot expect to always keep for himself every animal he raises. If his herd is purebred he has young bulls to dispose of occasionally and, be the herd purebred or grade, there comes a time when surplus females are to be sold.

Investigations show that when feed, labor and equipment are expensive, large profits do not accrue from milk production alone, even where good cows are kept under the most approved conditions. In many businesses the profits made on the principal articles manufactured are small. The large gains come from the by-products. And so it is with dairying. Were it not for the manure, the skim-milk and the calves, dairying would be a rather discouraging business, as is testified to by those who fail to utilize to best advantage these by-products.

The skim-milk and manure pay best when properly conserved and used on the farm but surplus stock must be sold to realize gain. Granting the correctness of the statement that the fundamental purpose of the dairy cow is to produce milk and butterfat, there is an economic fact that must be recognized if large annual profits are to be expected with certainty, and that is that the yearly increase of the herd must return a fair income either in cash, or by increasing the cattle assets of the dairy. It is for this reason that excellence of conformation, beauty of contour, richness of quality, uniformity of type and abundance of style are to be prized almost, if not quite, as highly as largeness and economy of production. It is for this reason that all operations pertaining to breeding, feeding and managing the dairy herd should be conducted on the big broad basis of producing milk and butterfat largely and economically while at the same time the herd is being built up along lines that will make all surplus animals—male and female—marketable at prices which will insure, beyond a doubt, profits worth while in return for efforts and intelligence expended. This means that animals offered for sale either privately or at auction should be so fitted and conditioned that the best qualifications they possess will be readily apparent to the prospective purchaser.

Fortunately, the care, feed and management which insure desirable production, growth, development and reproduction also develop in the animal the best possible condition for sale purposes. The well bred cow that is producing largely is always in demand at a favorable price. The healthy heifer or heifer calf that is vigorous, thrifty and growing well always finds a favorable market, and the young purebred bull backed up by acceptable records indicating that he will sire calves that will grow into large, handsome, highly productive cows sells quickly as a result of judicious advertising.

And yet there are various little things requiring small effort, trifling expense and very little additional time that add perceptibly to the attractiveness of animals and, therefore, to their selling prices. It is desirable, but not always practicable, to keep the herd always in attractive form, and it is essential to complete success to specially fit those individuals that are for sale.

Taking it for granted that the suggestions of the former chapters have been followed, such animals will be in prime condition for adding the few finishing touches. These should begin with daily grooming. Animals must be clean to be attractive. The curry comb should be used on the flanks, legs and belly only. The rest of the body should be cleaned with a soft brush and flannel rag. Vigorous yet gentle rubbing and grooming remove dirt and dust from the hide and hair, encourage oily secretions, and thereby soften the hide and hair, giving a bright, lustrous appearance indicative of quality. Animals like to be groomed and nothing else quiets and gives them confidence in their caretakers so quickly. Blanketing with a light cover, so made that it will remain on, keeps the animal clean, quickens the arrival of the handling qualities desired in the hair and hide and eliminates the necessity of clipping the entire body. Individuals naturally hard-hided and coarse-haired should wear a heavy blanket under the light one, and some animals should wear two, or even three, especially if the weather is cool.

Well mannered animals always outsell unruly or awkward ones, other things being equal. Every animal offered for sale should be provided with a neat halter and lead rope or strap and be taught to lead and stand posed at the end of this strap when being examined. A decent price should not be expected for an animal that stands with head down, with feet in four wrong directions, with back lowered, with rump drooping or with belly drawn up, when it is realized that but a few minutes a day for a short period of time is required to lead the same animal to water and to teach it to stand at the end of the lead strap with head up, feet under the body, back straight and rump elevated, showing at its best.

When the animal has been conditioned and trained even to this

slight, inexpensive degree, its value has been enhanced no less than 10 per cent, and oftentimes 100 per cent may be added.

More can yet be done if desired, but not much. A pair of power clippers is an excellent investment on every farm, for as much difference can be made in the appearance of an animal by clipping its head, ears and tail as can be made in the appearance of a long-haired man by the use of the same sort of an instrument in cutting his hair. But a few minutes is required for performing the task. It is well to clip the belly of dairy cattle that their mammary veins will show to best advantage and so that the milk wells can be located with greatest ease. Cows should also have all long hairs clipped from their udders, for this adds to the appearance of cleanliness and quality thereof. Especially does clipping add to the attractiveness of the dehorned cow's head, which is homely indeed in the eyes of most prospective purchasers if long, ragged hairs take the place of well trained, small, incurving horns.

But all horns are not assets. Long, sharp, misshapen horns detract from the selling value. The shrewd cattle man sees to it that every calf's horns start growing in the right direction and in accordance with the requirements of the score card of the breed his herd represents. If necessary he employs the use of horn trainers, which can always be secured at reasonable prices. As some cows and bulls grow old their horns naturally grow long and unsightly, often causing the wearers to become troublesome among their companions. Whether such animals are to be sold or kept, the sharp points should be sawed off and with rasp and file the horns should be reduced in size and rounded at the ends. Very long, coarse, ugly horns can be shortened and made sightly by filing the ends down to the quick once a month. After the horns are reduced in size and filed into proper shape, sandpaper, followed with emery paper, will smooth away the scratches, and these, followed with metal polish applied vigorously with a flannel cloth, will make of the vicious, long, crooked horn, which detracts from value, a sightly attachment which will add to the appearance and, therefore, add to the demand for the animal and to her selling price.

It may appear to the ultra-practical dairyman and breeder that these suggestions are far-fetched and that much time, effort and expense would be incurred in carrying them out; but it should be remembered that it is impossible to prepare a cow so she looks better than she really is, that only by preparing her to look her best can she be made to create a true impression on the prospective purchaser and bring for her owner her full value. After going to all the expense of time, effort and study to breed good cattle it is wasteful to sacrifice them by refusing to add the few hours and little expense necessary

to show them posed gracefully at the end of a neat lead rope, with horns trimmed and polished, heads, tails, udders and bellies clipped, and their hair and hide conditioned to show the true quality they possess.

The ones who profit most in the diamond industry are those who secure the diamonds in the rough and by cutting and polishing them reveal the real beauty and value they possess. So it is with cattle. Will you sell yours at a loss after years of patient effort in breeding, raising and developing, and let some one else in a few hours double their value by training and conditioning them; or will you add a few hours to the years you have already spent and earn for yourself the added profit in dollars and reputation?

Preparing for Auction

It is doubly necessary to prepare cattle that are to be sold at auction. When selling privately the prospective purchaser may listen to reasons why the animals appear untidy; it may be possible to convince him that they are large, economical producers and worthy to enter his herd, but cattle sell quickly at auction and the buyer bids according to the way the animal and its pedigree look to him on that day. There is no time for excuses or explanations. It has been many times truly said that good care, feed and management command better prices at the ringside of an auction sale than aywhere else.

To prepare a herd for auction the seller should plan far ahead. All females of milking age should be as nearly fresh and milking as largely as it is possible to have them, for, unwise as it is in many respects, a buyer will pay more for fresh cows than for those that are dry and soon to freshen, although in the latter case he could buy two for the sum he is willing to pay for one. However, most buyers fear to trust their judgment and take the risk of buying a dry cow, preferring to purchase one fresh and showing at her best. Therefore, it is but the part of wisdom for the seller to recognize the demand of the market and have his supply fit the demand as closely as possible.

There have been times when milking cows solely for manufacturing milk and butterfat was unprofitable. There have been times when raising cattle for sale only was unprofitable. The rule is that profits accruing from one without regard to the other are doubtful. But history does not and probably never will tell of the time when it has been or will be unprofitable to breed and develop good, large, handsome, highly productive dairy cattle, encourage them by efficient care, feed and management to produce at their best and, by proper fitting and advertising, sell the annual surplus from the herd for what it is really worth according to the demands of the market.